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Information

Electric Testing

Starting, Lighting and Ignition Systems

BOOK No. 6

BY
HARVEY E. PHILLIPS

PRICE 40 CENTS

Auto Electric Systems Pub. Co.
DAYTON, OHIO

Information

ELECTRIC TESTING

Starting, Lighting and Ignition Systems

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By
HARVEY E. PHILLIPS

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Auto Electric Systems Pub. Co.
DAYTON, OHIO

FOREWORD

This book is compiled for the benefit of all who care for and repair motor car electric systems.

By means of instructions, illustrations and diagrams, we have shown how we make tests on various pieces of electrical apparatus used on motor cars.

To make these tests as shown in this book, it is absolutely necessary that reliable instruments be used.

We have arranged with the Phillips Engineering Company of Dayton, Ohio, to supply their Model 32 test and charging set to all of our customers desiring an instrument of this kind.

The Phillips test and charging set was designed to be used by motor car mechanics and is reliable in every respect.

34 leading motor car manufacturers are recommending this instrument to their dealers and agents, therefore, we do not hesitate in offering it to you.

All tests illustrated in this book excepting Figure 56 and Figure 57 may be made with this instrument and correct results will be obtained.

To all who are in the motor car business we believe this book will be of great assistance.

Our next book will be on 1917 motor car electric systems.

H. E. PHILLIPS.

Realizing that nearly every motor car mechanic is called upon daily to repair or adjust something about the electric systems on motor cars, we have gathered the data contained in this book and have pictured the tests in a way that they should be easily understood.

Electric troubles are easily located and remedied if the mechanic understands the simple principles of electricity and electric terms.

To all who are new at this line of work we especially recommend our No. 1 book entitled Elementary Electricity, Motor Car Electric Systems and Delco Light. This book explains the meaning of electric terms in a way that they are easily understood. The instruction on elementary electricity is such that many of the best schools in the world have adopted this book for their elementary text.

The operation of an electric system is often compared to that of a water system as their operations are similar in nearly every way. Figures 1, 2, 3 and 4 are used to explain the first principles of the operation of a water system which may be compared to that of an electric system.

In Figure 1, the pump compares with the electric generator, the check valve with the cut-out relay, the valve with a switch, the pressure gauge with a voltmeter and the tank with a storage battery. When the pump is operated and the pressure of the pump becomes greater than that of the tank, the check valve opens and water flows to the tank.

As soon as the pressure of the pump falls below that of the tank the check valve closes and prevents the water in the tank from flowing back to the pump and being wasted. The pressure gauge shows the pressure in pounds.

When an electric generator is operated and the pressure of the generator becomes greater than that of the battery, the cut-out relay closes and permits current to flow to the battery. As soon as the pressure of the generator falls below that of the battery the cut-out relay opens and prevents

the current from the battery flowing back upon the generator and being wasted.

A voltmeter shows the electric pressure in volts. When the valve in the water line is opened, water will flow. When

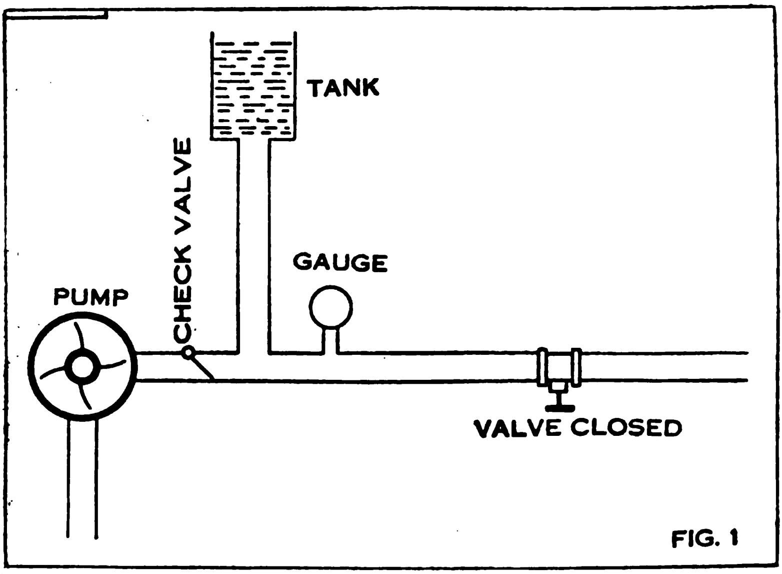


FIG. 1

a switch used in an electric system is closed current will flow.

Figure 2 is the same as Figure 1 excepting that two pressure gauges are used instead of one and the valve is partly open. If the pressure gauge nearest to the tank shows 50 pounds pressure, the pressure shown by the other gauge will be less due to the resistance offered to the flow of water by the valve which is only partly open.

The resistance offered to the flow of water by the valve in this system compares with poor switch contacts or a high resistance joint or connection in an electric system.

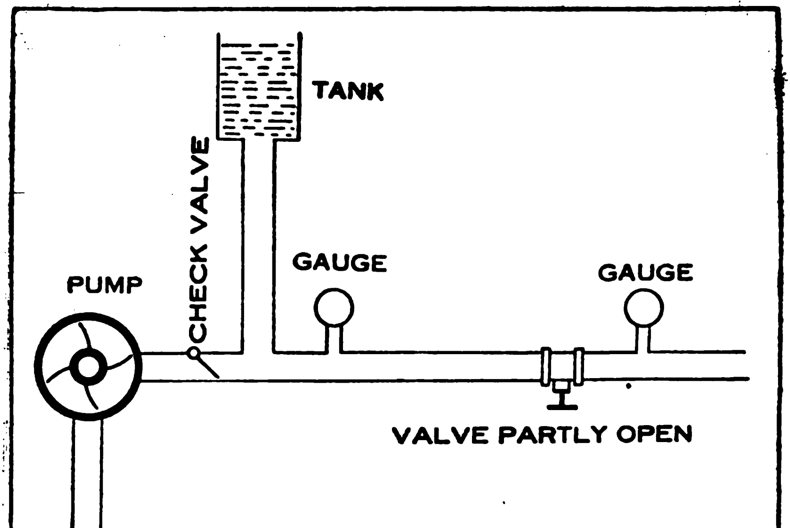


FIG. 2

Figure 3 shows a clog in the pipe. If the valve is all the way open the pressure shown by the gauge nearest the

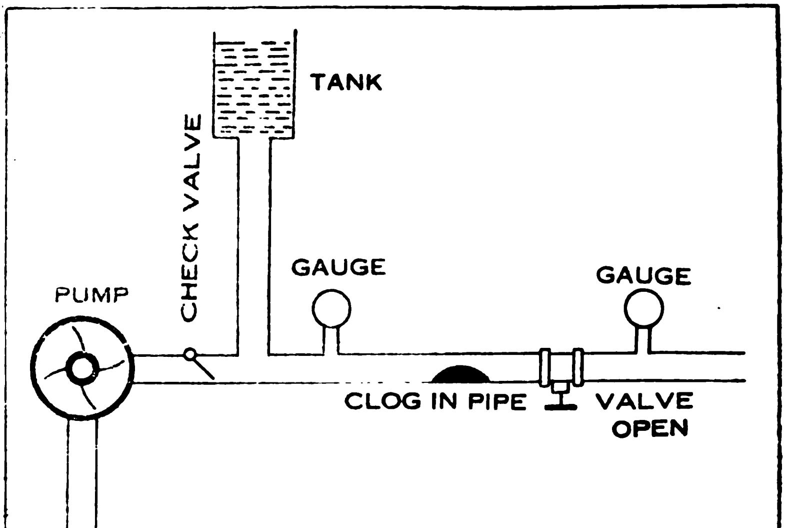


FIG. 3

tank will be much greater than that shown at the other gauge, due to the resistance offered to the flow of water by the clog in the pipe. The clog in the pipe of this system compares with poor joints or connections in an electric system.

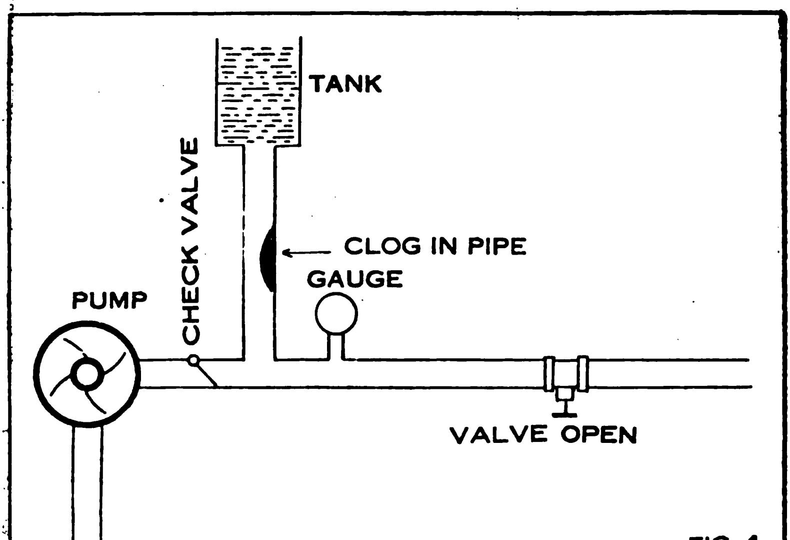


FIG. 4

Figure 4 shows a clog in the pipe from the main line to the tank. If the pump is operating the pressure shown by the pressure gauge will be extremely high due to the resistance offered to the flow of water to the tank, by the clog in the line. If the pump is not being operated and water is taken from the tank the pressure shown by the pressure gauge will be extremely low as the clog in the pipe will prevent a full flow of water.

It often happens with an electric system that when the generator is supplying current for lights or other demands that the voltage rises extremely high and when the generator is not running, the current then being supplied by the battery, the voltage will be extremely low.

When the generator is supplying the current the lights are exceptionally bright and when the battery is supplying the current the lights are exceptionally dim. In this case we always find a poor connection in one of the battery lines between the switch and storage battery. In the water system the clog in the pipe compares with the poor or loose connection in the electric system.

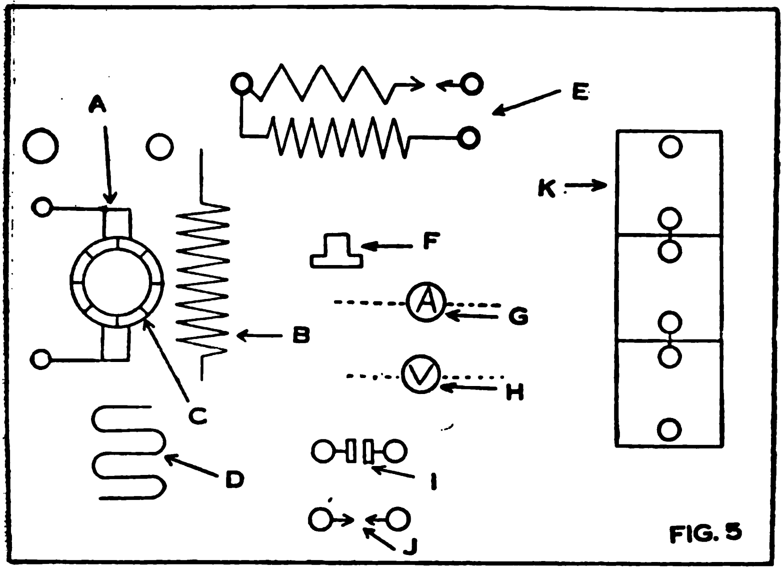


FIG. 5

Figure 5 shows a number of symbols which are used in the various illustrations. A shows a motor or generator brush. B a field coil. C a motor or generator commutator. D shows resistance wire. E shows a cut-out relay. F is a push button. G is an ammeter. H is a voltmeter. I and J are contacts. K is a storage battery. Study these symbols carefully and compare them with those used in the illustrations. In doing so the illustrations and parts will be more easily understood.

[redacted]

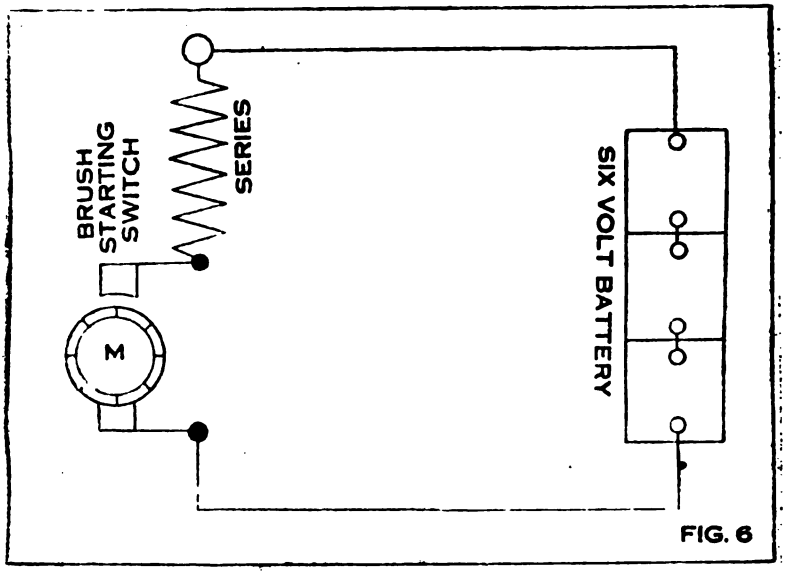


FIG. 6

Figure 6 shows a cranking circuit with the brush lifted. When the brush is lowered and comes in contact with the commutator the motor will operate. The upper brush acts as a starting switch. When the systems being tested are of the single wire type, the lower line from the battery to the generator or the motor should be considered the same as "Ground" or "Frame of Car." This applies to all illustrations of this nature.

Figure 7. A switch is used in the cranking circuit showing the contacts open. When a voltmeter is connected at the terminals of the battery as shown, it should always show six volts or a little over. In this case the battery is idle. This test is of little value as it is not an assurance that the battery is charged or is good.

A battery while idle may show a pressure of six volts and when put under a load the voltage will drop excessively. Should the voltage drop excessively the battery is weak due to discharge or may be defective.

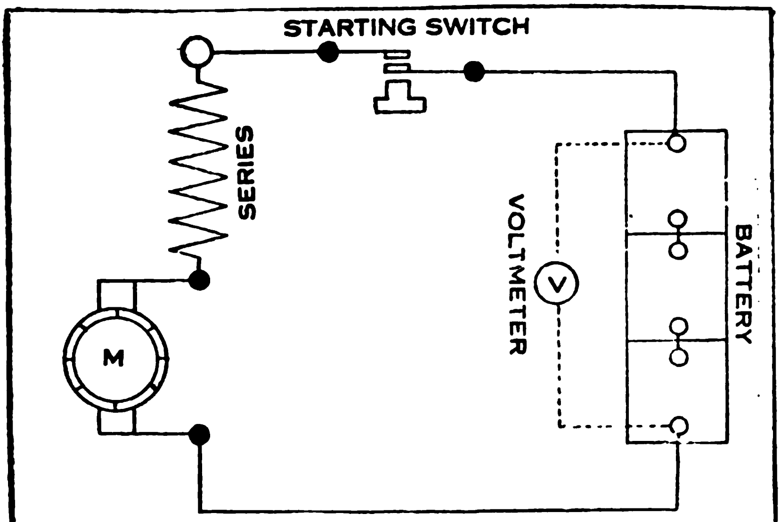


FIG. 7

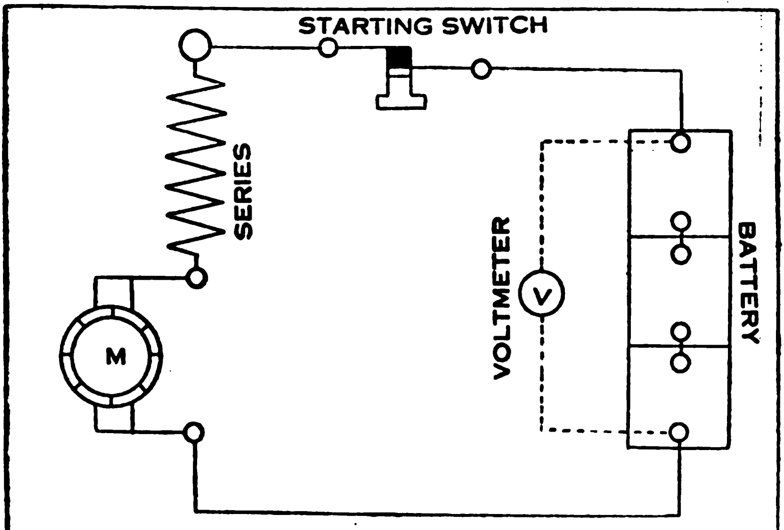


FIG. 8

Figure 8. This shows the starting switch closed and the voltmeter connected across the terminals of the battery. If

when the starting switch is closed the voltage drops excessively, the battery is at fault and the trouble is likely to be a discharged or defective battery. If the voltage drop is not over 1½ volts the battery is all right.

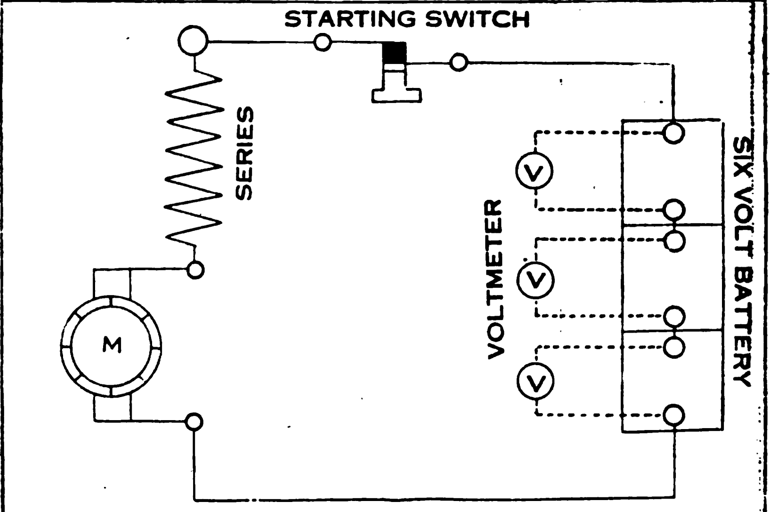


FIG. 9

Figure 9. This shows the starting switch closed and three positions of the voltmeter connected across the terminals of single cells. If the voltage dropped extremely low when making test as shown in Figure 8, then tests as shown in Figure 9 should be made, taking voltage of each cell separately.

If the voltage of all cells is low then it is likely that the battery is weak due to discharge. If part of the cells show the voltage to be all right and others show low voltage it is likely that the ones showing low voltage are defective. To be sure of this, first try charging the low cells individually and see if they can be brought up to a charged condition. Then make test again as shown in Figure 9.

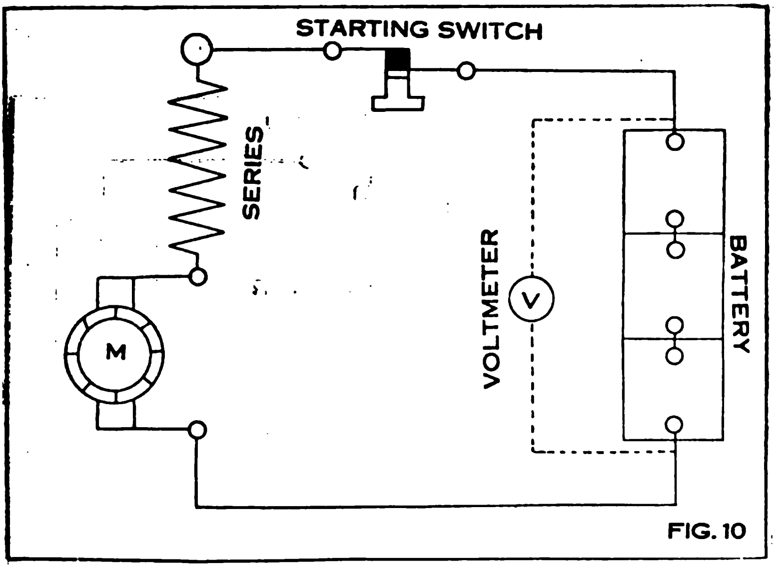


FIG. 10

Figure 10. This shows the starting switch closed and the voltmeter connected to the terminals of the wires at the battery. If voltage was all right when test was made at the terminals of the battery as shown in Figure 8 and there is a decided drop in voltage when test is made as shown in Figure 10 the terminal connections at the battery are loose or corroded.

If a corroded condition is found they should be cleaned at once. To remove corrosion, first take all of the battery bolts, nuts and washers off of the battery and put them in a strong solution of cooking soda and water. Let them remain in this solution for 10 or 15 minutes. Then use a stiff brush on them and be sure they are clean.

It may be necessary to scrape them to entirely remove the corrosion. After they are cleaned they should be given a good coat of vaseline. Clean the terminal posts of the battery with the same solution, being careful not to allow the solution to get into the battery. Be sure to give all

terminal parts a good coat of vaseline before and after they are assembled. Then make test as shown in Figure 10. The voltage drop should not be excessive.

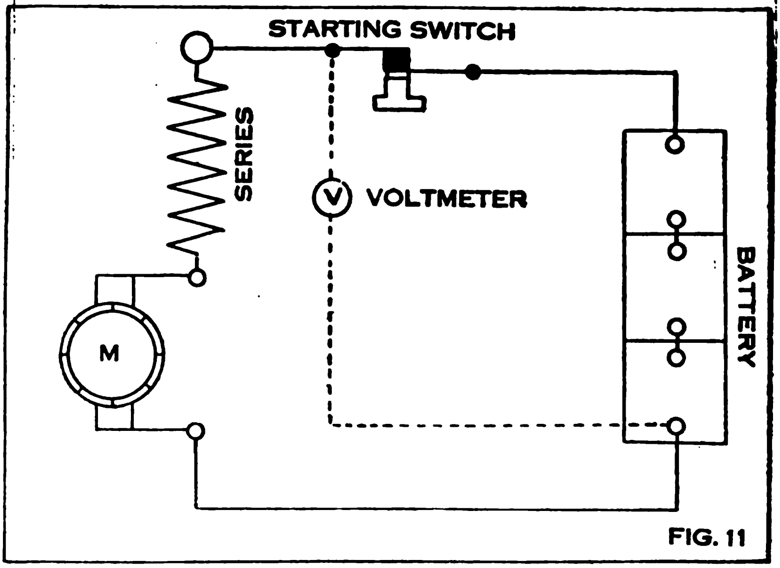


FIG. 11

Figure 11. This shows the starting switch closed and the voltmeter connected to one side of the battery and to one side of the switch. If the drop in voltage is great at this point, it is likely that the switch contacts are bad. To determine this, make test as shown in Figure 12.

Figure 12. This shows the starting switch open and the voltmeter connected across the terminals of the starting switch. The voltmeter should show the full voltage of the battery. Then make test as shown in Figure 13.

Figure 13. This shows the voltmeter connected across the terminals of the starting switch and the starting switch closed. When the starting switch is closed, the voltmeter should not show a reading. If it does show a reading, the starting switch contacts are either dirty or defective.

Figure 14. This shows starting switch closed and voltmeter connected to the terminal of the motor and one side

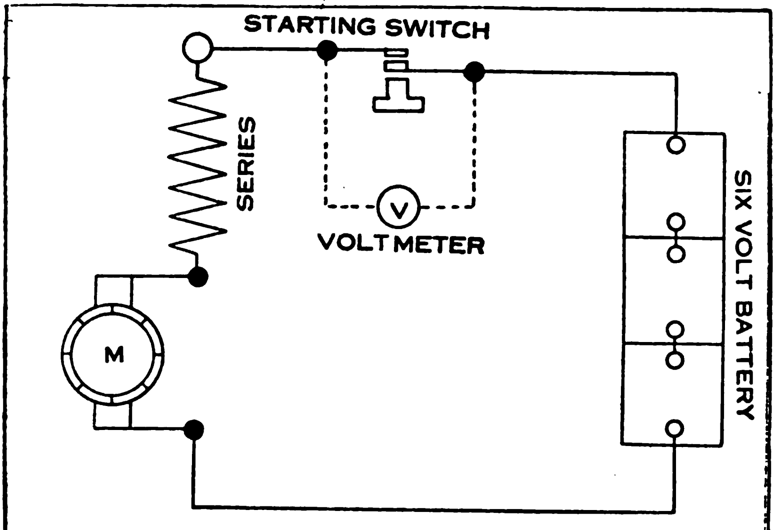

STARTING SWITCH
SERIES
VOLTMETER
V
M
SIX VOLT BATTERY

FIG. 12

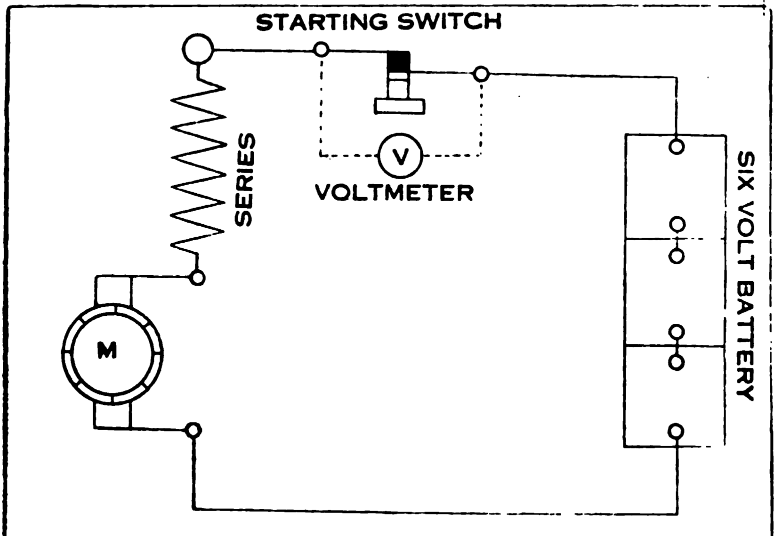

STARTING SWITCH
SERIES
VOLTMETER
V
M
SIX VOLT BATTERY

FIG. 13

of the battery. If voltage is all right at this point and the starter fails to operate properly, it is an indication that the motor is defective.

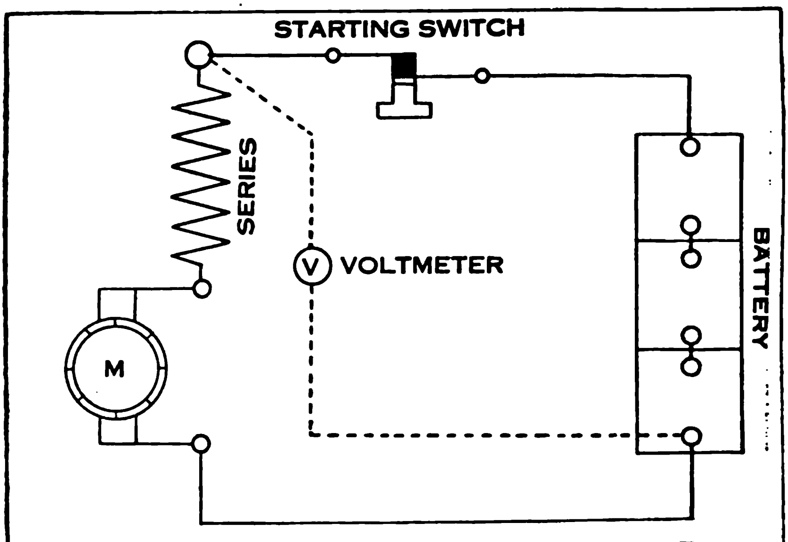


FIG. 14

The troubles may be due to worn out motor brushes, brushes stuck up in holders, brushes not properly fitted to the commutator, weak brush spring tension, dirty commutator, high micas, low segments, loose or poorly soldered connections or open field windings. To test for open field windings, first make test as shown in Figure 14 and then make test as shown in Figure 15.

Figure 15. This shows the voltmeter connected to the brush end of the field coil and to the battery. If voltage was all right when test was made as shown in Figure 14 and voltage is low or no voltage at all is shown in test Figure 15, the field coil is open or there are loose or poorly soldered connections to the field coil.

Be careful to note the position of the starting switch at all times. WHEN VOLTAGE TESTS are made the starting switch should be closed.

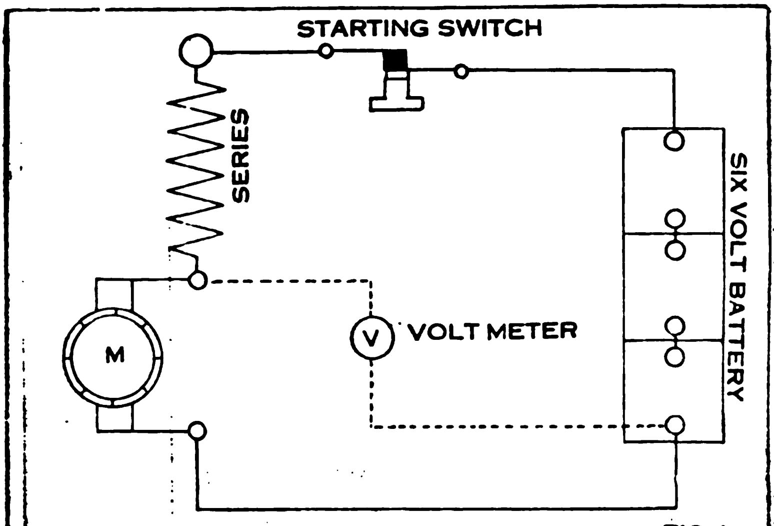


FIG. 15

Figure 16. This shows the starting switch closed and the voltmeter connected at the brushes of the starting motor.

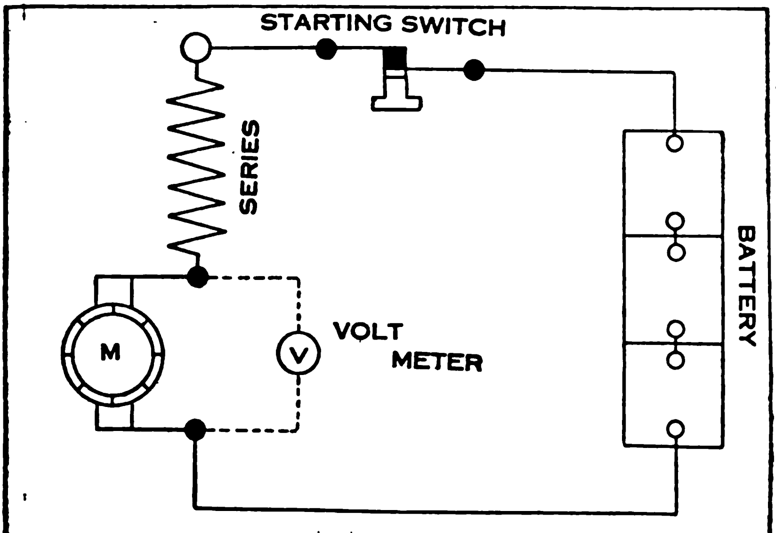


FIG. 16

If voltage is all right at this point, then inspect the conditions of the commutator and brushes as described under Figure 14.

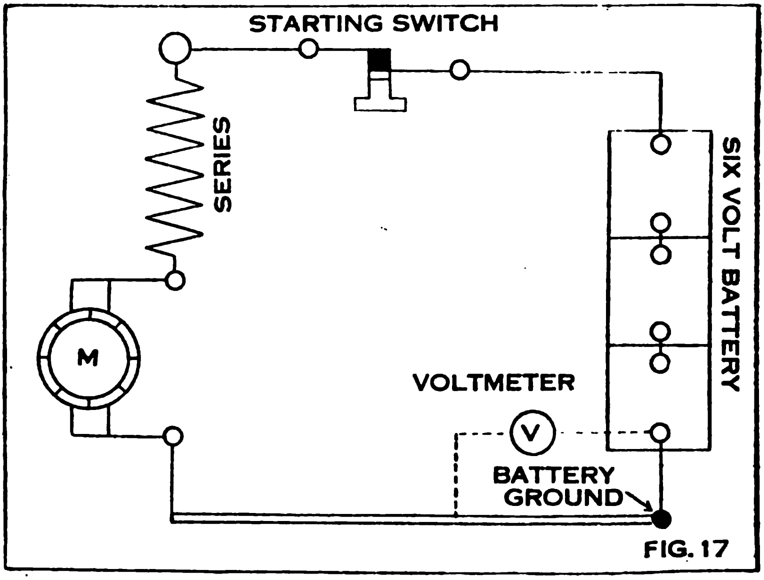


Figure 17. This shows starting switch closed and the voltmeter connected to the ground terminal of the battery and the other side of the voltmeter connected to the frame of the car. If the voltmeter shows a reading, the ground connection at the frame of the car is poor.

Remove the battery ground connection to the frame of the car and clean the connection as well as the frame of the car at the point where the connection is to be made. Then give the cleaned surfaces a good coat of white lead. Attach the terminal to frame of car and be sure that a good tight connection is made. Make test over again. Voltmeter will not show a reading then.

Figure 18. This shows a method of testing a storage battery. To make this test, first secure 9 feet of No. 16 soft iron wire and wind it in the form of a spiral spring. Then

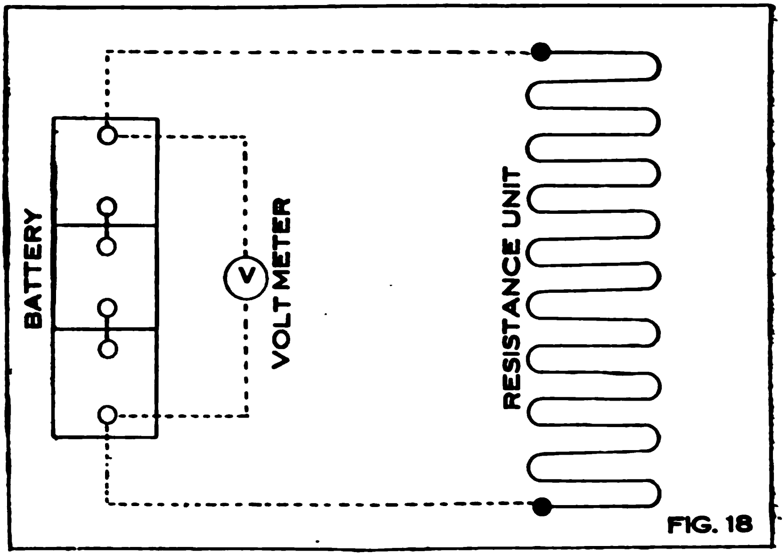


FIG. 18

stretch the spring so that when the ends are released that no two coils of the spring touch each other and short out a part of the wire. This may be used as a resistance unit. Then connect voltmeter as shown.

The voltmeter should indicate six volts or a little over. Leaving the voltmeter connected to the terminals of the battery, connect resistance unit as shown. If a decided drop in voltage is noted, the battery is either weak due to discharge or bad cells exist.

Figure 19. This shows three positions of the voltmeter connected to a single cell. Leaving the resistance unit connected to the battery as shown in Figure 18, test each cell for voltage separately. If voltage of all cells is alike the trouble is likely due to discharge. If the voltage of one or two cells is extremely low, it indicates bad cells.

Unless you are experienced in battery repairing it is best to take the battery to a battery service station. When the resistance unit is connected at the terminals of the battery

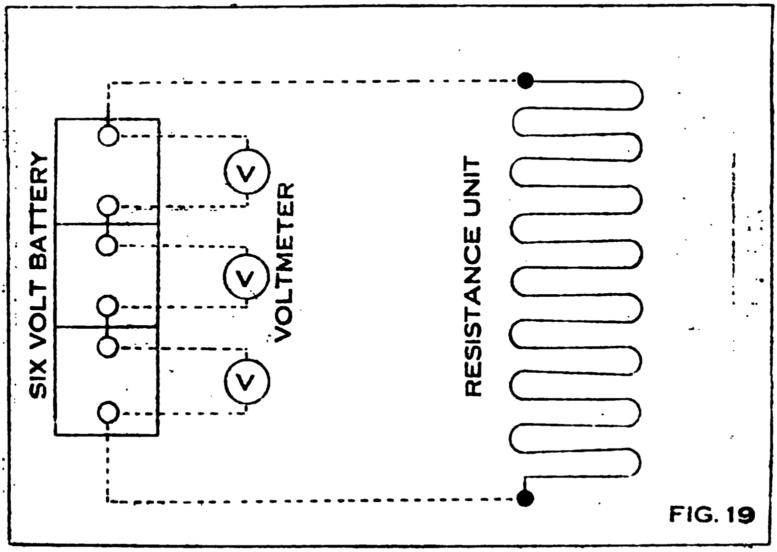


FIG. 19

as shown in Figure 18 and Figure 19 the battery is being discharged at about a 30 ampere rate.

Figure 20. This shows a generator wired to a battery with an ammeter connected in series with them and a voltmeter connected across the lines between the generator and the battery. The circuit is completed by hand in this case. In many systems when the ignition switch is turned to the "ON" position it also causes these contacts to close.

The voltmeter shows the pressure of the generator and the ammeter indicates the output of the generator. Connected as shown it will not indicate discharge of the battery for lights or horn.

Figure 21. This shows a generator wired to a battery. Contacts are closed by hand. Note the dotted line between generator terminals. Field regulators should be connected to these two terminals in all generators where this dotted line appears between these terminals.

Figure 22. This shows a generator wired to a battery with a cut-out relay connected in one side of the line. The

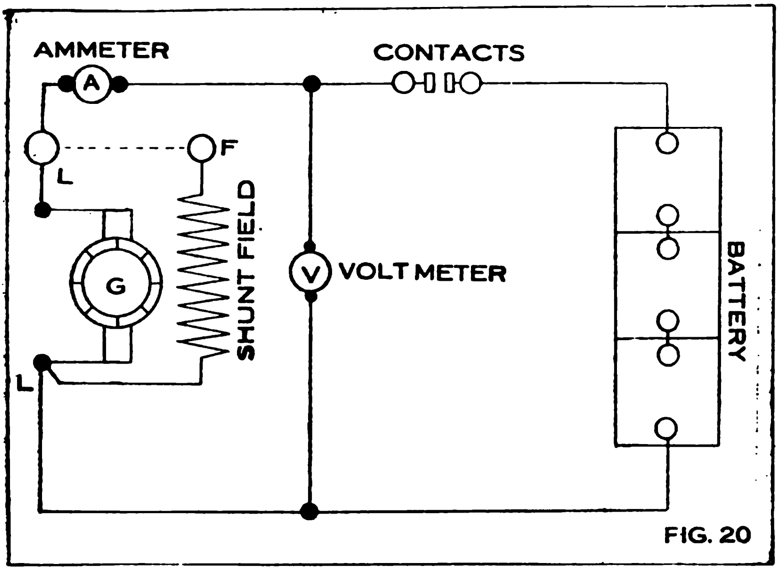

AMMETER
A
CONTACTS
F
L
SHUNT FIELD
G
V
VOLT METER
BATTERY
L

FIG. 20

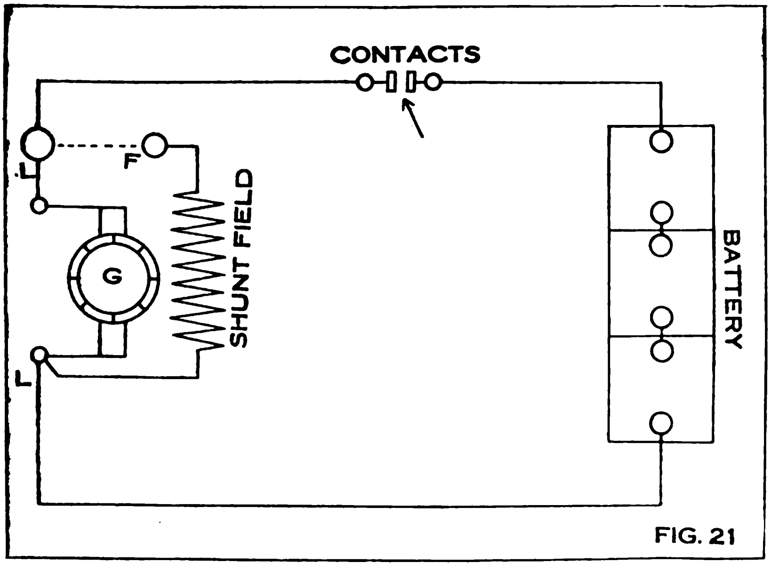

CONTACTS
L
F
SHUNT FIELD
G
BATTERY
L

FIG. 21

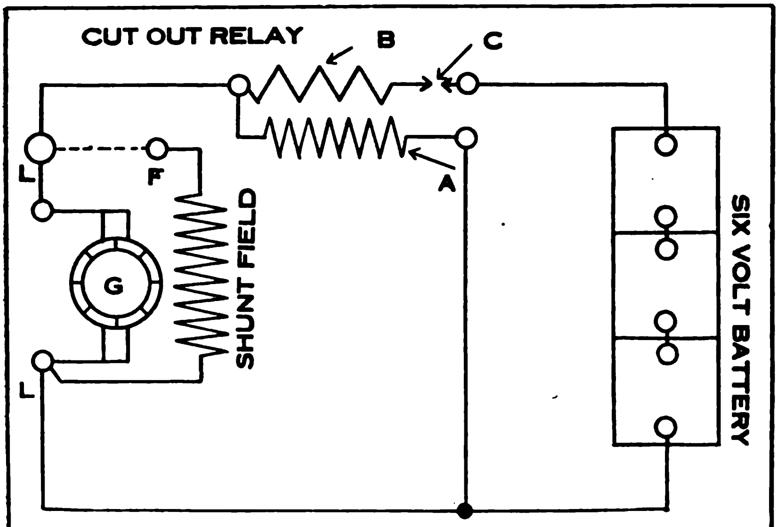


FIG. 22

cut-out relay takes the place of the contacts in the two preceding figures and is automatic. In this sketch "A" is the voltage winding, "B" is the primary winding and "C" is the contacts.

Figure 23. This diagram is the same as Figure 22, excepting that the cut-out relay contacts are closed. The cut-out relay closes the circuit between the generator and the storage battery when the generator voltage is high enough to charge the battery.

It also opens the circuit as the generator slows down and its voltage becomes less than that of the battery, thus preventing the battery discharging back through the generator. The cut-out relay is an electro magnet with a compound winding. The fine voltage winding is connected directly across the terminals of the generator as shown.

The primary or course winding is in series with the circuit between the generator and the storage battery. The contacts are closed and opened at contacts "C" (see Fig.

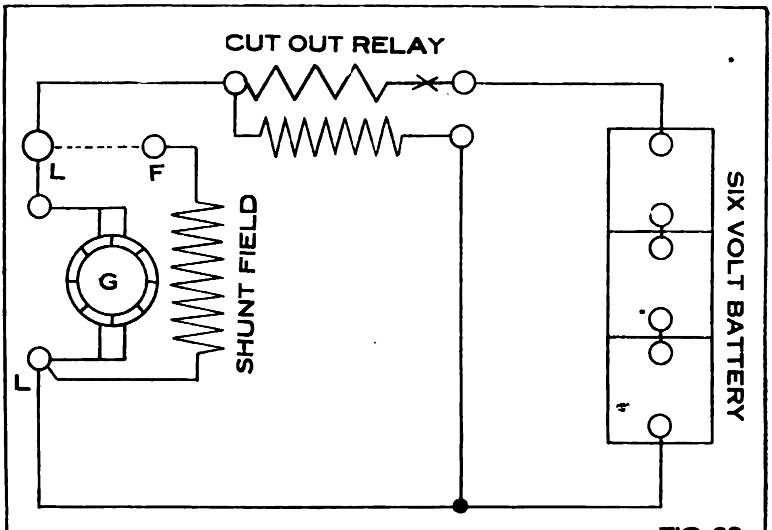


FIG. 23

22). When the engine is started the generator voltage builds up and when it reaches about 7 volts, a current passing through the voltage winding produces enough magnetism to overcome the tension spring (see Figure 50), attracting the armature to the core which caused the contacts to close.

The contacts close the circuit between the generator and the storage battery. The current then flowing through the coarse winding increased the pull on the armature and gives a good contact of low resistance at the contact points. When the generator slows down and its voltage drops below that of the storage battery, the battery sends a reverse current through the coarse wire windings which kills the pull on the armature.

The tension spring then pulls the armature away from the core and the contacts are opened and will remain so until the generator is operated again.

Figure 24. This shows a bridge between terminals "L" and "F" of the generator. When an external regulator is

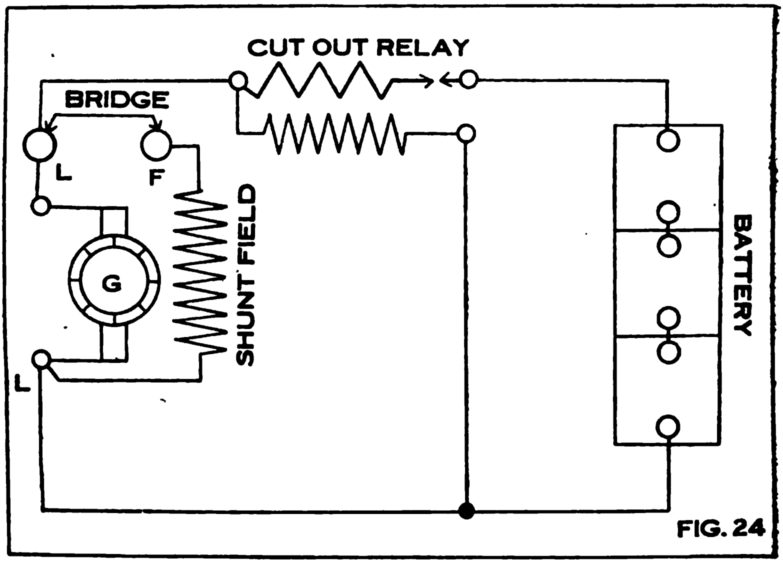


FIG. 24

used and generator does not generate, make test as shown by bringing these terminas together with a piece of wire. If generator now generates, the difficulty lies in the regulator or circuit to it. If may be said that the regulator circuit is open.

Figure 25. This shows an ammeter connected across the primary terminals of the cut-out relay. If, when the generator is running and it does not close at the proper time, test as shown. If generator is generating the ammeter will show a reading. This indicates an open circuit in the primary or coarse wire circuit.

If when armature is pressed and contacts are closed the generator charges battery, look for open voltage winding.

Figure 26. This shows test for open shunt field. Be sure to disconnect all wires from the generator. Then use test cord from 110-volt circuit with lamp cut in on one side of the line as shown. If the lamp burns at all or there is a spark when the two pionts are touched as shown the shunt field is not open.

[redacted]

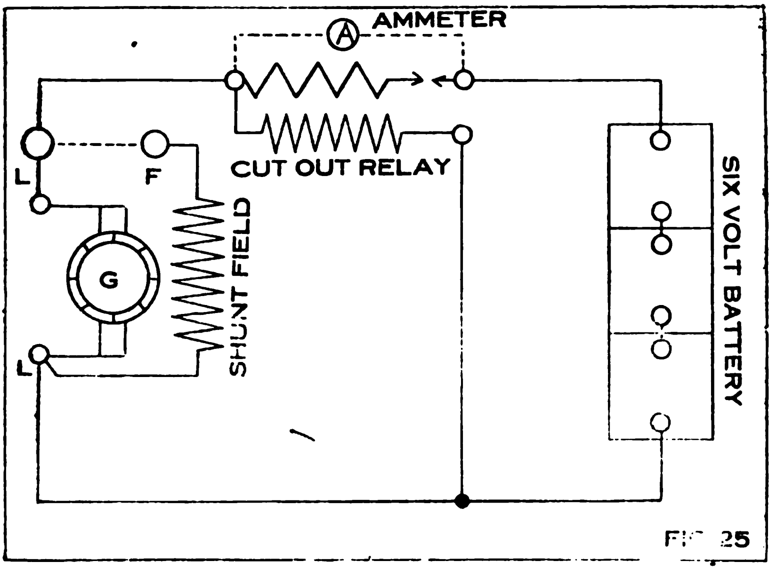


FIG. 25

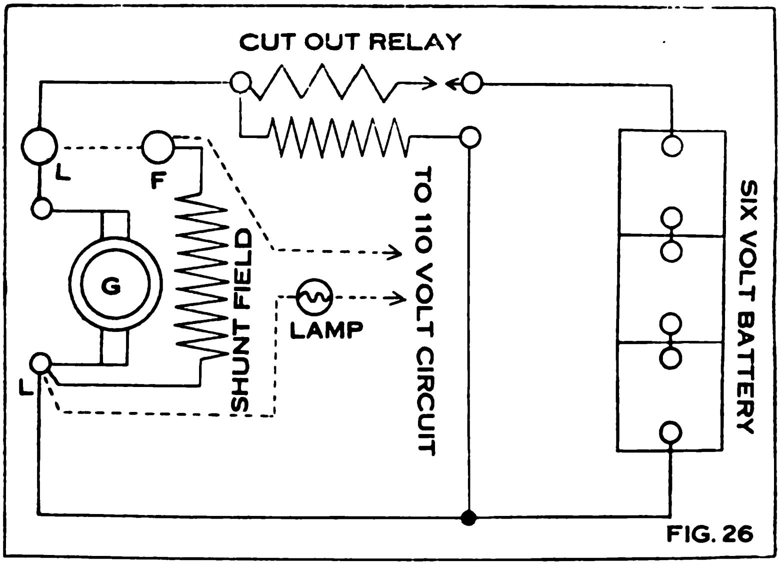


FIG. 26

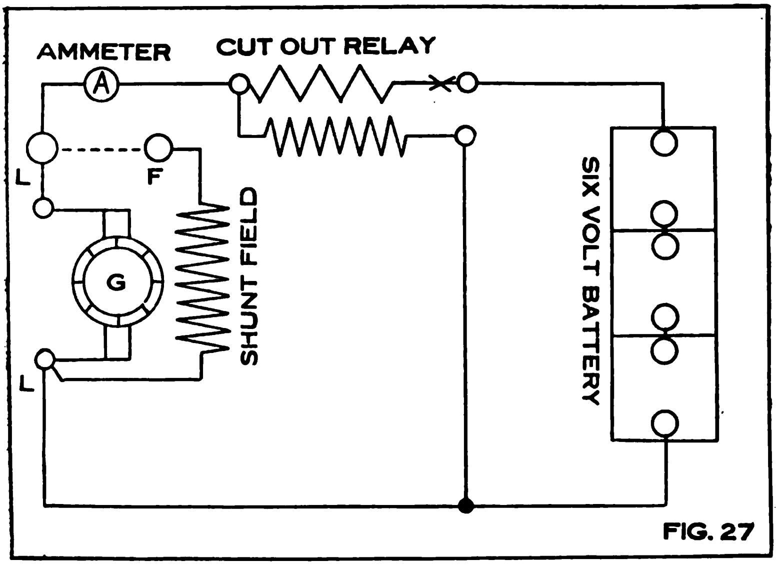


FIG. 27

Figure 27. This shows the ammeter connected near the generator terminal which will show the output of the generator. In many cases short circuits occur in the lines between the generator and the storage battery. First make the test as shown which gives the output of the generator. Then make test as shown in Figure 28.

Figure 28. This shows the ammeter connected in the circuit between the generator and the storage battery, near the battery. This will show the rate the battery is being charged. If the generator is generating current at a 15 ampere rate and the battery is being charged at a much lower rate, there is a loss in the line due to short circuits or grounds.

To make these tests be sure that your lights are not burning and if ignition is taken from the generator system an allowance must be made for that.

Figure 29. To be sure that a cut-out relay is regulated right, connect the voltmeter across the generator terminals.

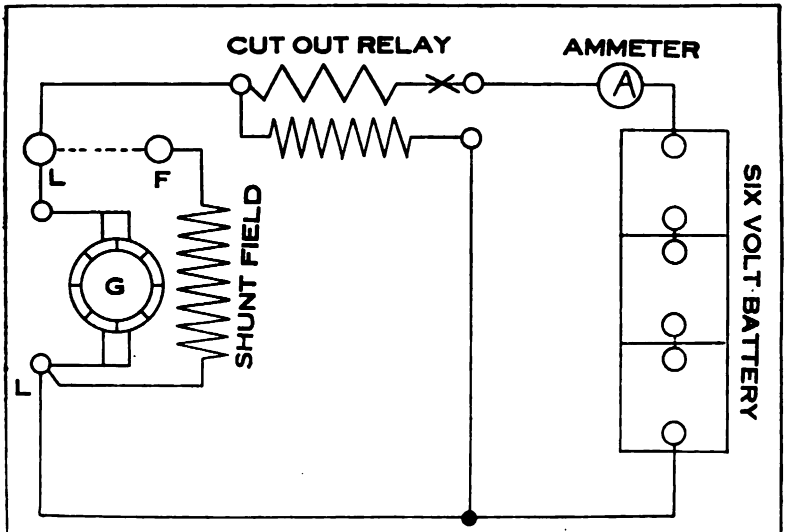

CUT OUT RELAY
AMMETER
A
L
F
SHUNT FIELD
G
L
SIX VOLT BATTERY

FIG. 28

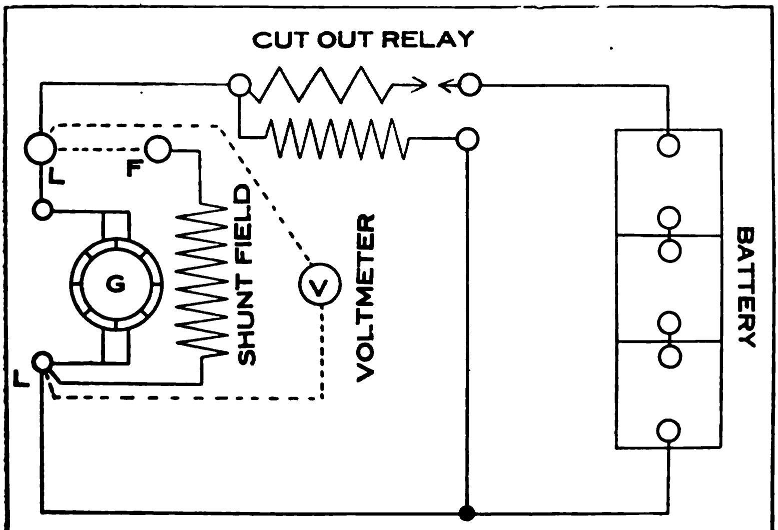

CUT OUT RELAY
L
F
SHUNT FIELD
G
V
VOLTMETER
L
BATTERY

FIG. 29

Then have engine running. Watch the voltmeter and cut-out relay closely. When the voltage of the generator reaches seven volts the cut-out relay should close.

If the two circuits are all right through the relay, then note the tension of the tension spring. If the relay closes too soon, stiffen the tension spring; if it does not close soon enough, weaken the tension sprnig. Do not change the tension of the spring very much at a time.

While doing this testing it is well to slow the engine down and then increase the speed slowly, watching the voltmeter and cut-out relay closely.

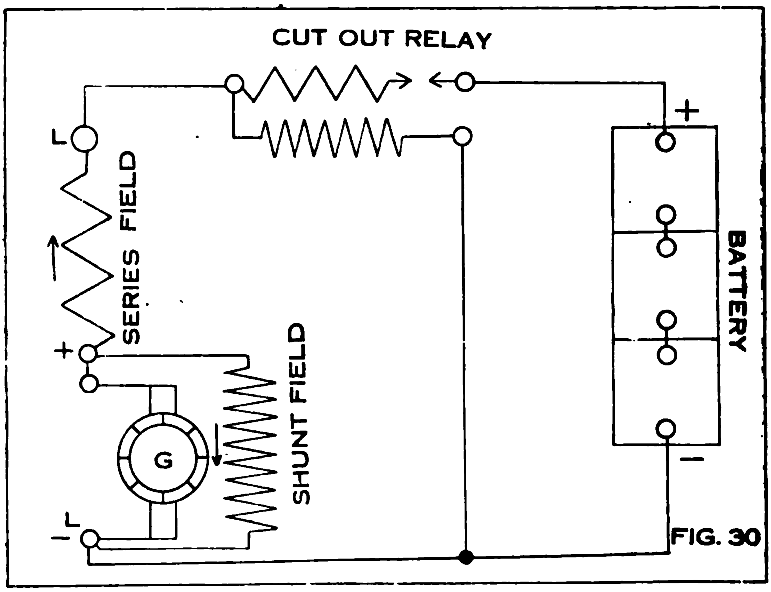


Figure 30. This shows the reverse series type of regulation. Note that the shunt winding is connected across the brushes and that the series is connected in series with the line and generator. When generator is generating the current from the generator must pass through the reverse series. This produces a bucking effect against the shunt winding.

As the speed of the engine increases the bucking effect increases up to an average speed of 30 miles per hour. At that time the bucking effect will not let the shunt field build up any higher. It may be said that the generator will act as a constant current machine at all speeds above 30 miles per hour.

If it is necessary at any time to increase the output of the generator, short circuit the reverse series. If the generator is of the motor generator type, then be sure to remove this short circuit before attempting to crank the engine with the starter.

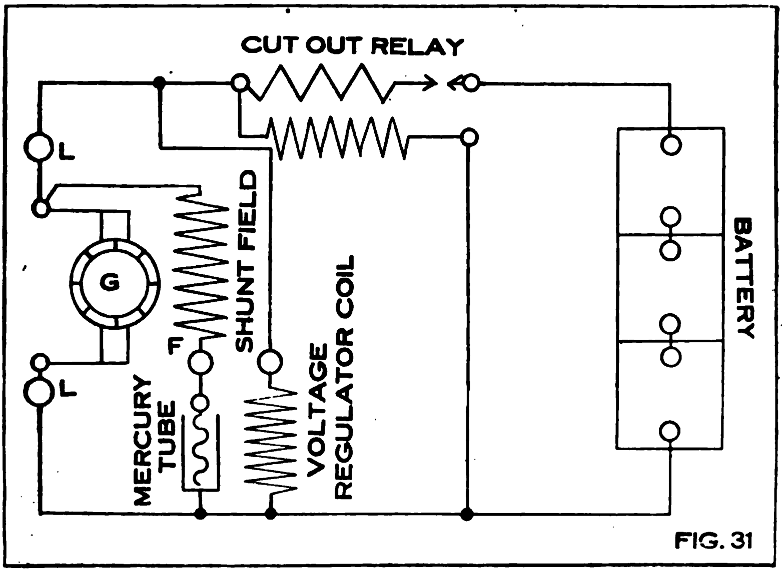


Figure 31. This shows the mercury operated voltage regulator. The most important parts of the voltage regulator are as follows: Regulator or magnet coil, mercury tube, plunger, resistance wire and mercury. The regulator or magnet coil surrounds the upper half of the mercury tube. Within the mercury tube is the mercury and plunger.

The plunger is an iron tube with a coil of resistance wire wrapped around the lower portion on top of a special insu-

lation. One end of the resistance wire is connected to the lower end of the tube and the other end is connected to a needle carried in the center of the plunger. The lower portion of the mercury tube is divided by an insulating tube into two concentric wells, the plunger tube being partly immersed in the outer well and the needle in the inner well.

The space in the mercury tube above the body of the mercury is filled with an especially treated oil which serves to protest the mercury from oxidization, to lubricate and to form a dash pot for the plunger.

The operation is as follows: In as much as the voltage of the storage battery varies with its condition of charge, the intensity of the magnetic pull exerted by the regulator or magnet coil upon the plunger varies, and causes the plunger to move in and out of the mercury. When the battery is in a discharged condition the plunger assumes a low position in the mercury tube and vice versa.

When the plunger is at a low position, the coil of resistance wire carried upon its lower portion is immersed in the mercury and as the plunger rises the coil is widthdrawn. Now the current to the shunt field of the generator must follow a path leading into the outer well of the mercury, through the resistance coil wound on the tube to the needle carried at the center of the plunger, into the center well of the mercury and out of the regulator.

It will be seen that as the plunger is withdrawn from the mercury, more resistance is thrown into this circuit, due to the fact that the current must pass through a greater length of resistance wire. This greater resistance into the field of the generator causes the amount of current flowing to the battery to be gradually reduced as the battery nears a state of complete charge, until finally the plunger is almost completely withdrawn from the mercury, throwing the entire length of the resistance coil into the shunt field circuit, thus causing a condition of practical electric balance be-

tween the battery and the generator, and eliminating any possibility of overcharging the battery.

Figure 31 shows the mercury tube and resistance wire that is wound on the plunger. Also shows the regulator or magnet coil.

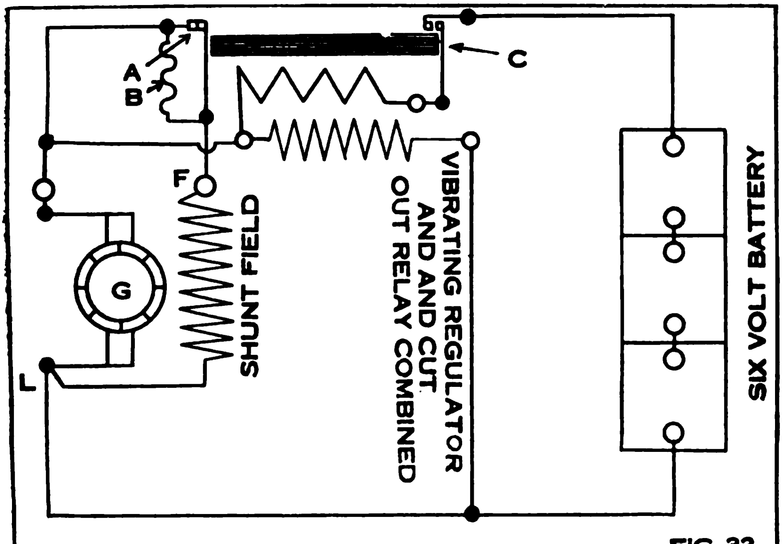


FIG. 32

Figure 32. Shows the vibrating regulator type of regulation. In this figure is shown a combination cut-out relay and vibraing regulator combined in a simplified form so they may be easily understood.

The relay core is shown above the coarse winding. "A" is the regulator contacts. "B" is regulator resistance and "C" is the armature of the cut-out relay. The operation of the cut-out relay is practically the same as described under Figure 23. The regulator is set so as to start to vibrate when the output of the generator reaches a certain amount.

Each time the armature of the regulator is pulled toward the core of the regulator, contacts "A" are opened, insert-

ing resistance "B" into the circuit. This reduces the current that passes through the shunt fields. At higher speeds the regulator vibrates faster and keeps the resistance in the circuit a greater portion of the time, thus making the generator act as a constant current machine at higher speeds.

Ninety-five per cent of all troubles of a vibrating regulator occurs at the regulator contacts "A." They become dirty or burned. If burned, smooth them up with a fine jeweler's file and then finish with real fine sand paper. If they are only dirty, use only real fine sand paper. When doing this work be careful not to change the tension on the springs containing the contacts.

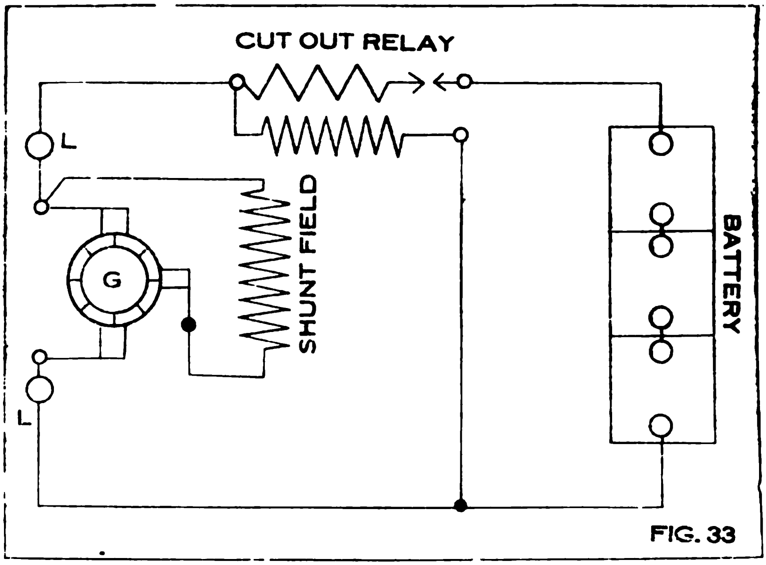


FIG. 33

Figure 33. This shows the circuits of a generator employing third brush regulation. As this is described fully under "Third Brush Regulation" in our No. 3 book we are omitting it here.

Figure 34. This shows the lighting wires tapped off the two lines from the storage battery to the storage battery. There

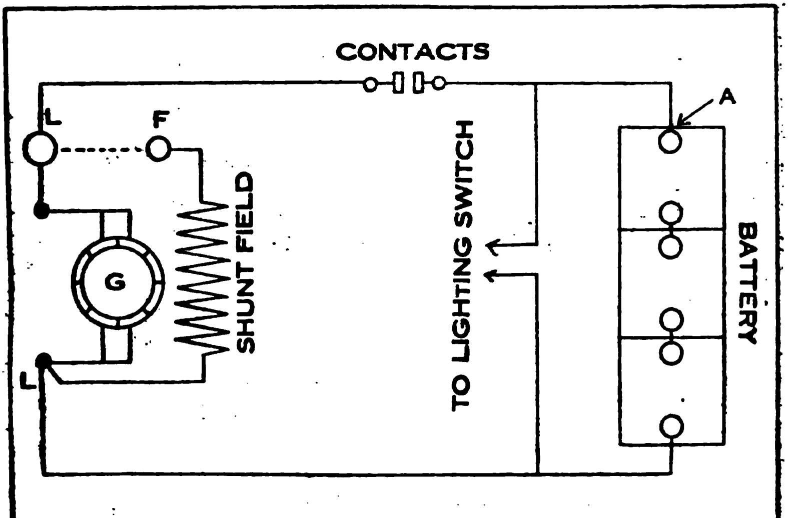


FIG. 34

is a corroded joint or connection at "A." When the generator is running and supplying current to the system the lights would be exceptionally bright and when the current for the lights is taken from the battery the lights are dim. This is due to the corroded or high resistance connection as shown.

Figure 35. This shows a standard lighting circuit with the voltmeter connected across the terminals of the battery and switch contacts open. The voltmeter indicates the battery voltage, battery idle.

Figure 36. This shows same circuit as in Figure 35, excepting that the lighting switch contacts are closed. If the battery is good and is charged the voltage should not drop so as to be noticeable. If it drops when lights are turned on, make test as shown in Figure 37.

Figure 37. This shows same circuit as in Figure 36 excepting that three positions of the voltmeter is shown. If voltage dropped when making test as shown in Figure 36,

[redacted]

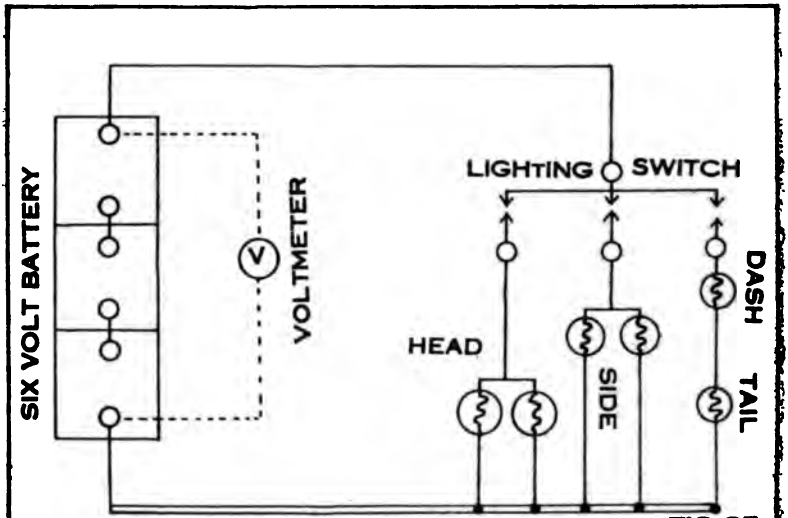


FIG. 35

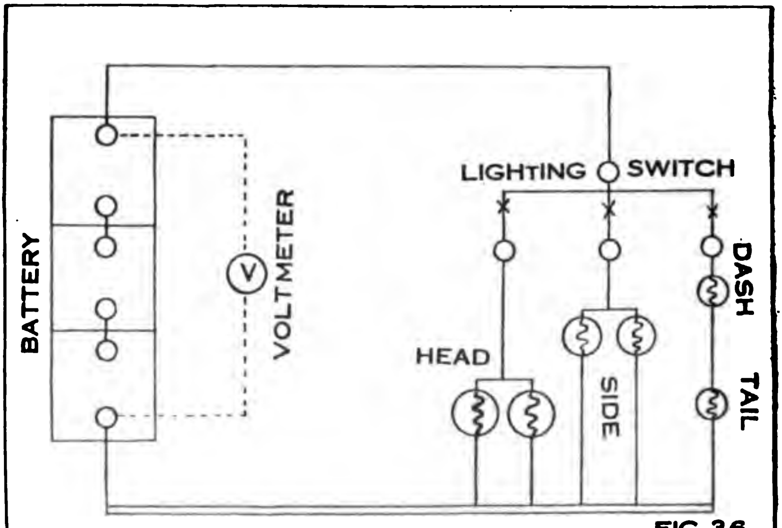


FIG. 36

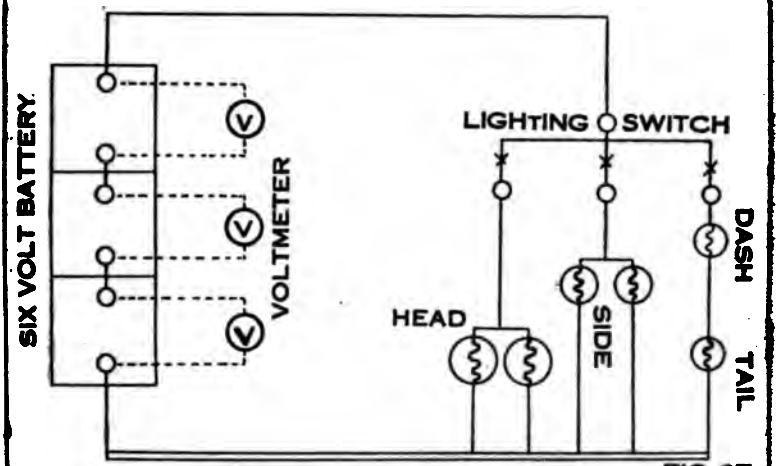


FIG. 37

test each cell separately for voltage, being sure to have all lights on. If one cell is lower than the rest it may be bad. If all cells show a voltage alike, it indicates discharge.

Figure 38. This shows same circuit as in Figure 37 excepting that the voltmeter is bridged across the lights and lighting switch. This gives the voltage up to the lighting switch. Full battery voltage should be maintained up to this point.

Figure 39. This shows same lighting circuits as in Figure 38 excepting that the lighting switch is in the off position and the voltmeter is connected across the contacts of the headlight circuit. The voltmeter should show the full voltage of the battery.

Figure 40. This shows same lighting circuit as in Figure 39, excepting that head light switch contacts are closed. When head lights are turned on, the voltmeter should not give an indication. If it does the switch contacts are bad or there is a bad connection in the switch in this circuit.

[redacted]

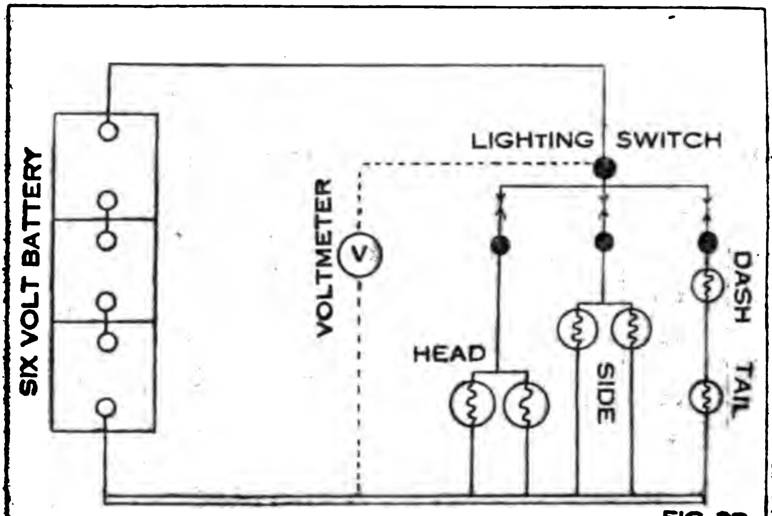


FIG. 38

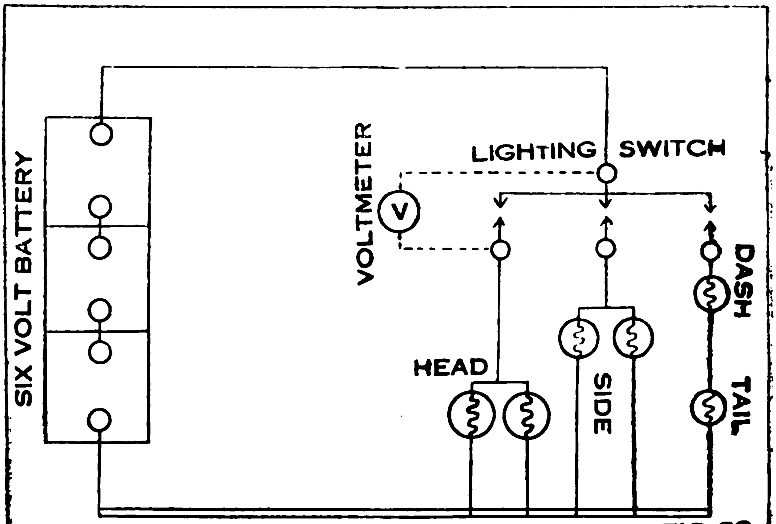


FIG. 39

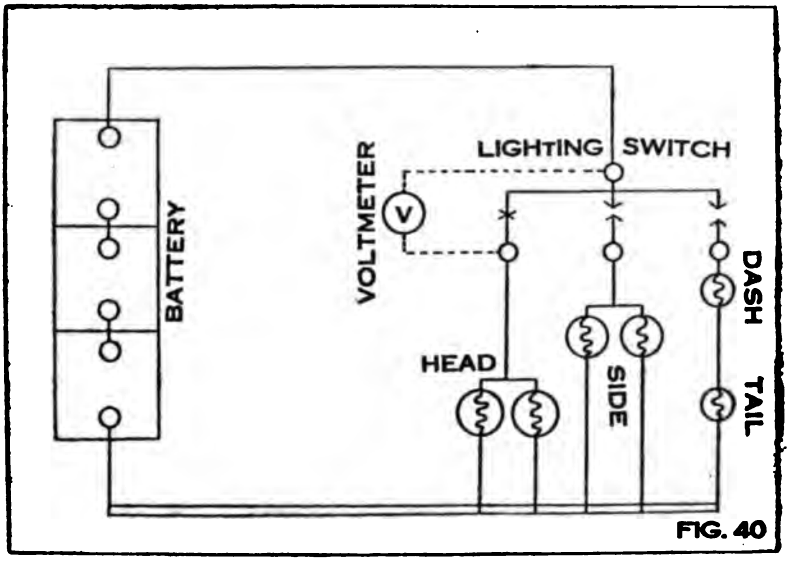


FIG. 40

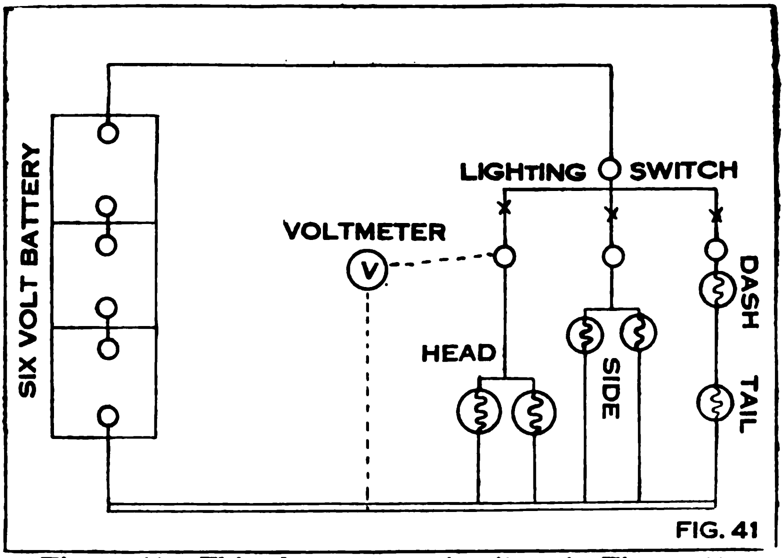


FIG. 41

Figure 41. This shows same circuit as in Figure 40 excepting that all switch contacts are closed and the voltmeter

is bridged across the head lights from the switch to the opposite side of the line. The voltmeter should show full voltage up to this point.

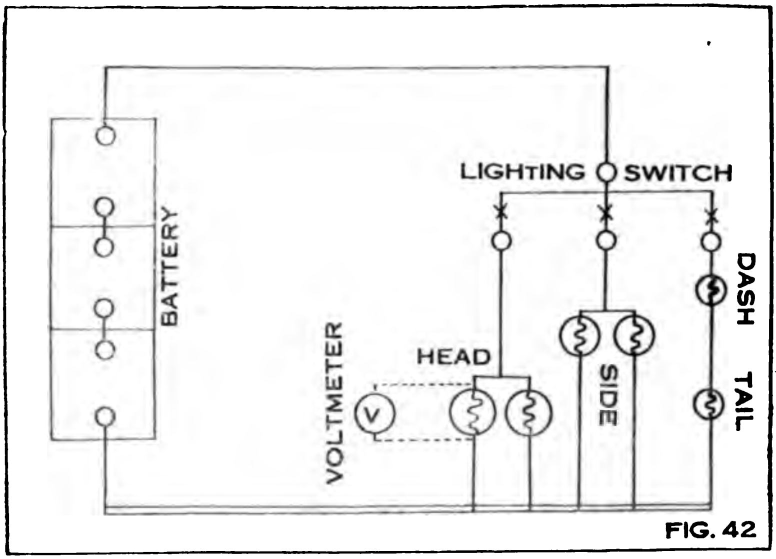


FIG. 42

Figure 42. This shows same circuit as in Figure 41 excepting that the voltmeter is connected directly across the head lights. There should not be a drop of over one-half volt over that of a reading taken at the terminals of the battery. If voltage is all right up to this point and the light burns exceptionally bright, the voltage of the lamp used is too low for the system.

If he voltage is all right and the lamp burns exceptionally dim, the lamp is of too high voltage for the system or is old and nearly burned out.

Figure 43. This shows the primary winding of an induction coil as used for ignition purposes connected in series with an ammeter and a six-volt storage battery,. This is a practical test for open or partially short circuited primary winding.

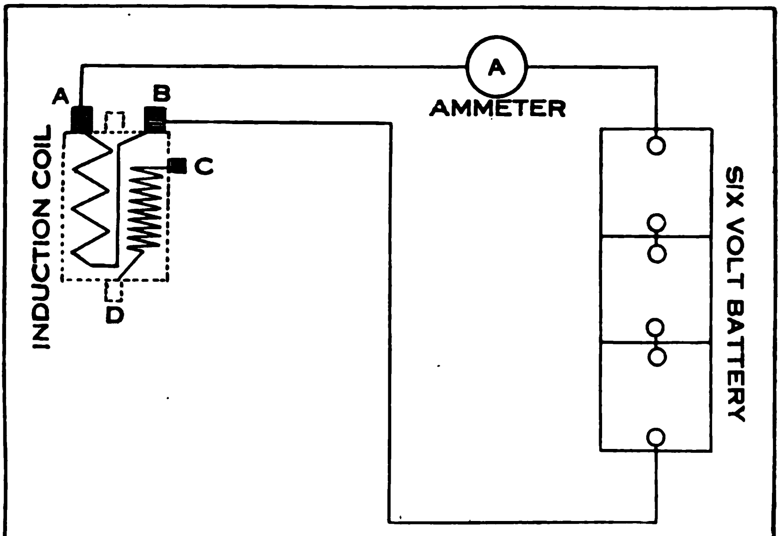


FIG. 43

If ammeter does not show a reading the primary winding is open. With the primary winding of an induction coil connected in the circuit as shown, about ten amperes will flow. This will vary with the different makes of coils. If an excessive amount of current flows it indicates a partial short circuit of the primary.

To be sure of this, first take a coil that is good and note the amount of current that will flow through the primary. Then try the same test with the coil that is to be tested. Be sure that the coils used in these tests are of the same make and construction. If in doubt at any time as the construction of a coil, write its manufacturer for this information.

Figure 44. In this diagram one side of the circuit is connected to one end of the primary of the induction coil and the other side of the circuit is connected to the secondary winding of the coil. If the voltmeter shows a reading, these two windings are either connected together in the construction of the coil or they are shorted together. In

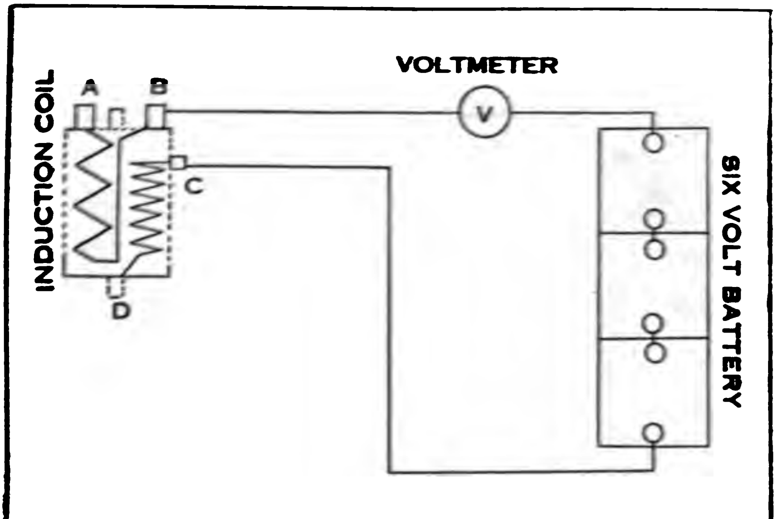


FIG. 44

the construction of some coils the primary and secondary are connected together while in others they are not connected. Be sure of this when making tests. Note that in Figures 43 and 44 that the secondary is not connected to the primary.

Figure 45. This shows same coil as shown in Figure 44. The voltmeter is connected in series with the secondary winding and a storage battery. If the storage battery does not show a reading the secondary winding is open. If the secondary is all right the voltmeter should show a reading of about half the voltage of the battery or three volts.

Figure 46. This shows the same test as in Figure 45, excepting that the primary and secondary of the induction coil are connected together in the construction of the coil.

Figure 47. This shows a standard battery ignition circuit using a timer. Note that the condenser is connected across the timer contacts. By making and breaking the

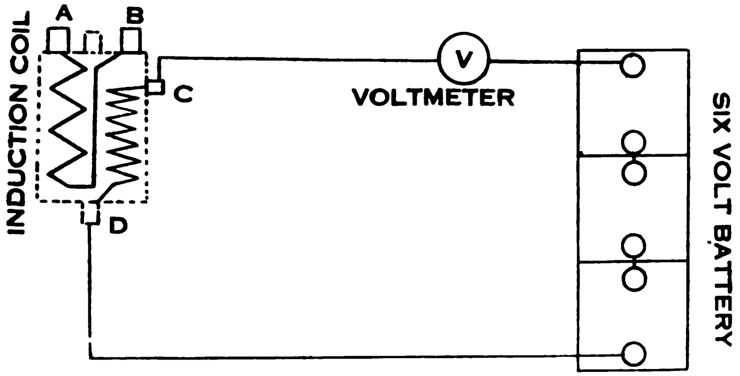

INDUCTION COIL
A
B
C
D
VOLTMETER
V
SIX VOLT BATTERY

FIG. 45

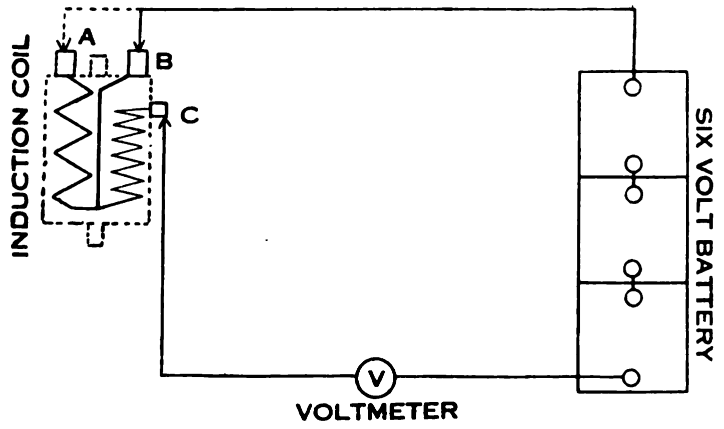

INDUCTION COIL
A
B
C
V
VOLTMETER
SIX VOLT BATTERY

FIG. 46

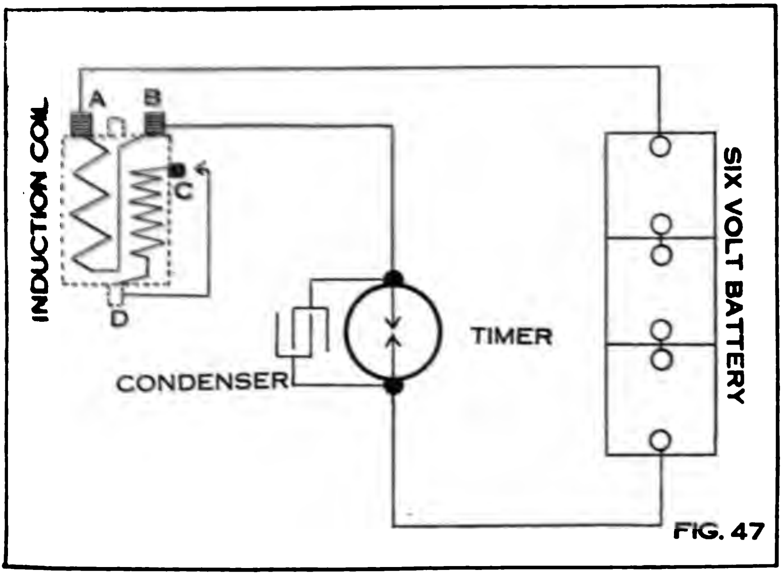


FIG. 47

primary circuit at the timer contacts and connecting a piece of wire to the secondary terminals of the coil as shown a spark should be produced at the terminals of the secondary. Always be sure to have a condenser connected across the point where the circuit is broken when making these tests. Each time the timer is in operation and the contacts open a spark should occur at the terminals of the secondary. Have a one-fourth inch gap between the secondary terminal and the wire.

Figure 48. This shows the same circuit as in Figure 47, excepting that a resistance unit is connected in the circuit. A resistance unit is used in nearly all battery or generator ignition systems. It serves to regulate the flow of current used for ignition and protects the coil if switch is left on and the engine is not running.

To test the condenser, first make and break the circuit with the timer and note the sparking at the timer contacts. Then disconnect one side of the condenser and hold this con-

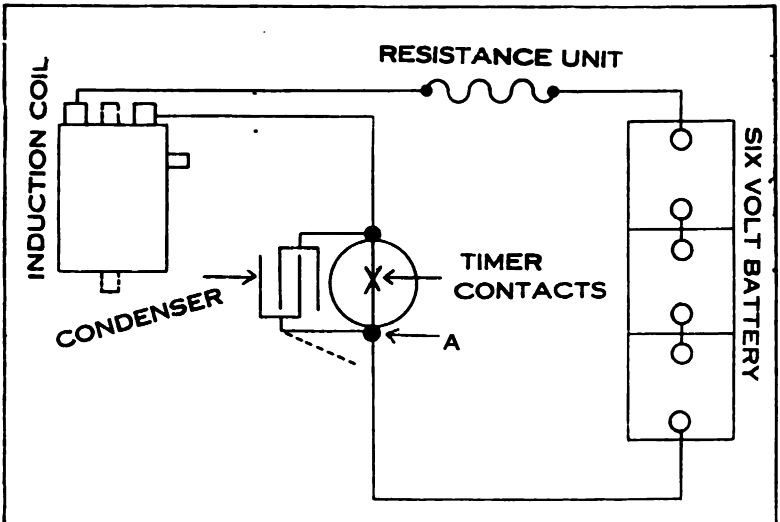


FIG. 48

nection away as shown by the dotted line. Now make and break the circuit with the timer and note the sparking at the timer contacts. If the condenser is good there should be considerable difference in the sparking at the timer contacts when the condenser is connected and when it is not connected.

Figure 49. This shows another method of testing a condenser. If the lamp burns with the wires at "A" held apart, the condenser is short-circuited. If the lamp does not burn the condenser is not short-circuited, but it may be open-circuited. To determine this, momentarily bring the ends of the test wires at "A" together. If the condenser is good the spark obtained will be snapping and similar to that obtained when a wire is connected across the terminals of a storage battery, although much less in volume. If such a spark is not obtained the condenser is defective. It would be well to compare the resultant spark obtained at the wires at "A" with and without the condenser in the

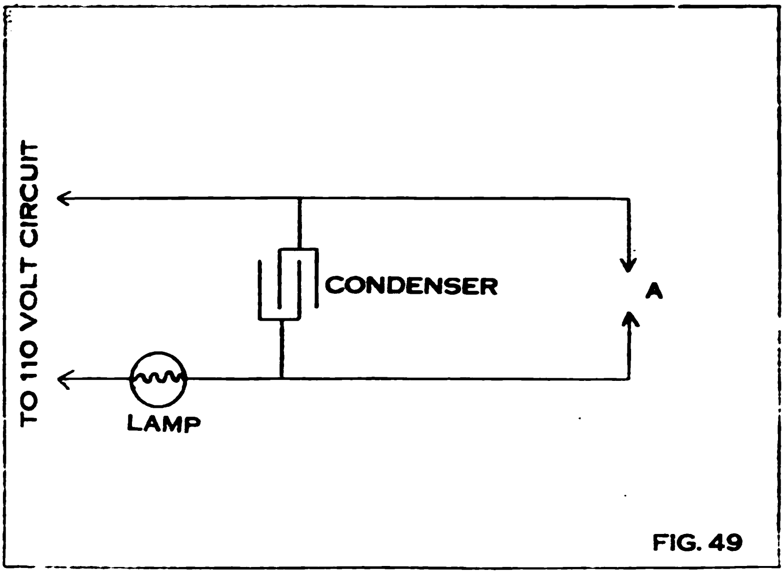


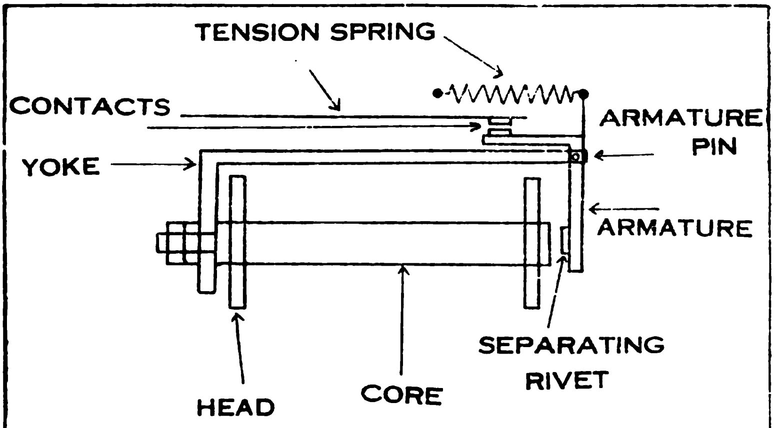
FIG. 49

circuit. There should be considerable difference in the quality of the spark. With the condenser in the circuit the spark should be snapping and without arcing. Without the condenser in the circuit an arc should be noted.

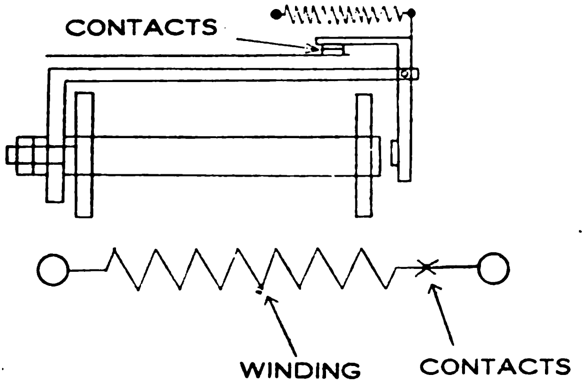
Figure 50. This shows the frame of the cut-out relay. In many cases the separating rivet was filed off. This rivet is there to prevent the armature from touching the iron core. The rivet is either made of German silver, brass or copper. These metals are not effected by magnetism.

If the armature should touch the iron core it would form a complete magnetic circuit which might cause the relay to be slow in opening or it might not open at all. Note that all parts of the relay are given names in diagram.

Figure 51. This shows the frame, contact and armature arrangement and the circuit of a standard vibrating circuit breaking relay. A circuit breaking relay is so constructed



CUT OUT RELAY FIG. 50



CIRCUIT BREAKING RELAY FIG. 51

and adjusted that when over a certain amount of current flows through it it will vibrate. It takes the place of fuses.

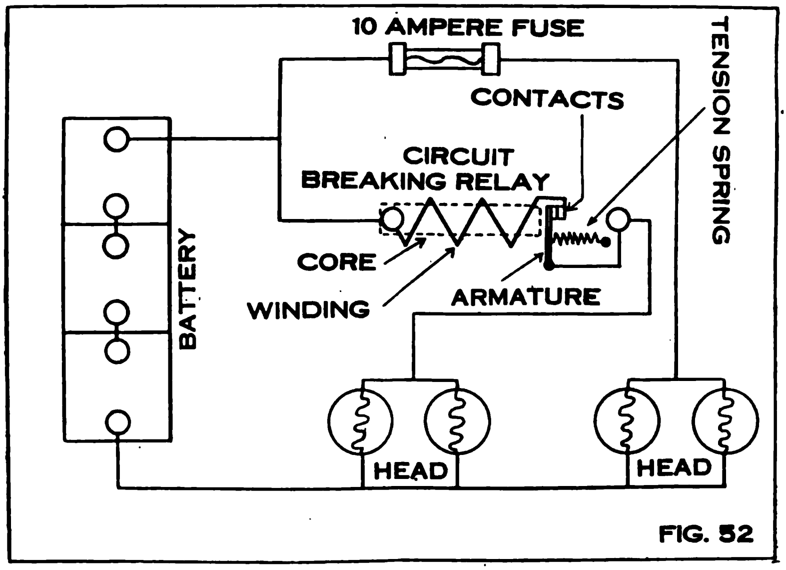


FIG. 52

Figure 52. This shows a circuit breaking relay in a head light circuit and a fuse in another head light circuit. If an overload or more than 10 amperes passes through the fuse, it will blow and open the circuit and must be replaced with a new one. The circuit breaking relay is set so as to start vibrating when over a certain amount of current is taken through it. It will vibrate until the current is turned off or the amount of current flowing through it is back to the amount it is set for. The circuit breaking relay acts as an automatic fuse.

Figure 53. This shows the circuit of a lockout circuit breaking relay. Note that there are two windings, a primary and a holding coil. The contacts are in a closed position.

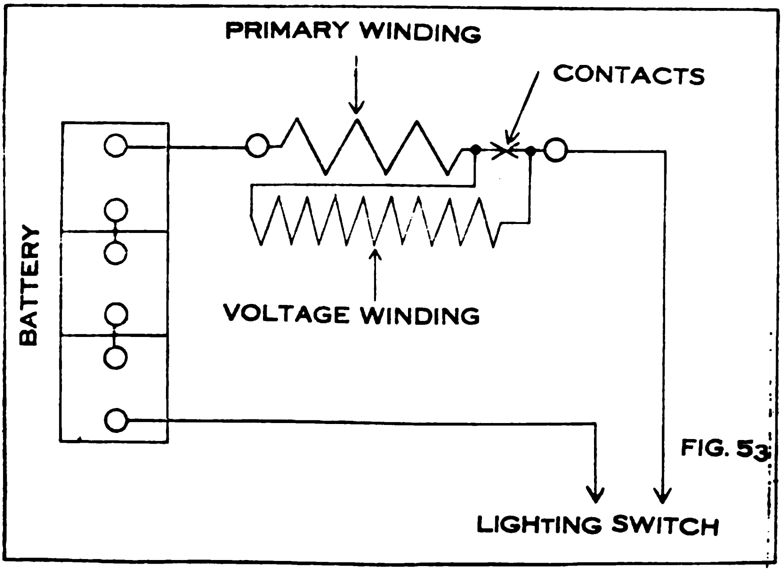


Figure 54. This shows the same circuits as shown in Figure 53, excepting that the relay contacts are open. When an overload is put on the relay the armature must pull toward the core of the relay, this opening the contacts. Before the contacts are opened, current flows only through the primary.

When the contacts open current flows through both windings which causes the contacts to be held open. They will remain open until current is cut off when the armature will be released and the contacts will go back together again and will remain so until an excessive amount of current attempts to flow through the relay again.

Figure 55. This shows a storage battery, resistance unit, ammeter and wires to be connected to the terminals of a circuit breaking relay. To make the resistance unit, secure about 30 feet of No. 16 soft iron wire. Wind it in the form of a spiral spring and then stretch the spring until when released the coils of the spring do not touch each other.

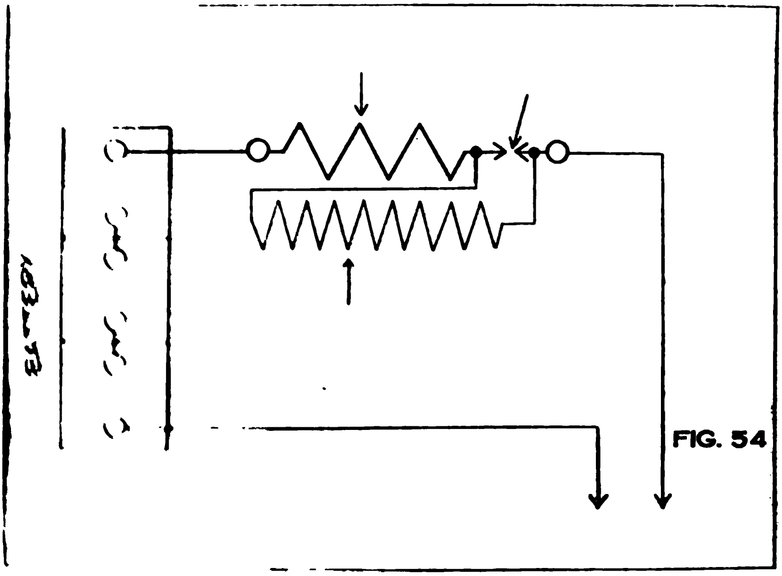


FIG. 54

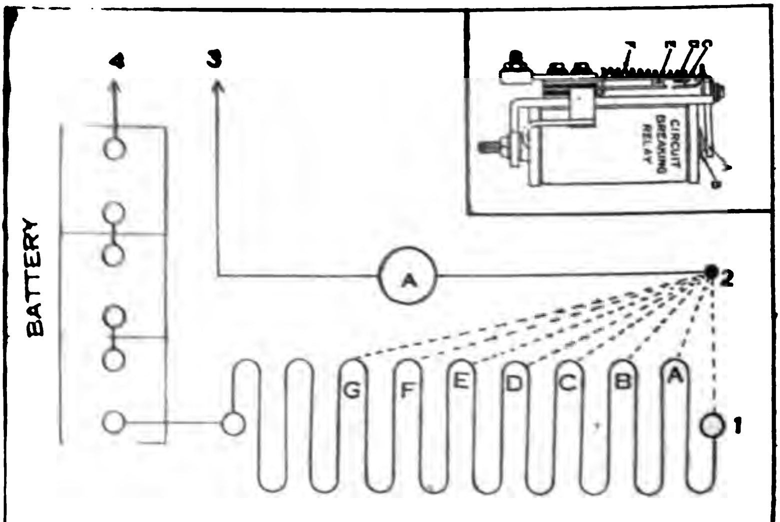


FIG. 55

To set the relay to break the circuit when a given amount of current flows through it, proceed as follows: Be sure that there are no connections between terminal 1 and 2, or from terminal 2 to the resistance unit. Then connect wires 3 and 4to relay. Now connect a wire to terminal 2. Then touch the other end of this wire to terminal 1 and note the reading of the ammeter.

Less than ten amperes will flow. Now touch the wire that is connected to terminal 2 to the coils of the resistance unit as shown at "A," "B," "C" and so on, watching the ammeter each time contact is made. If the relay is to be set to break the circuit at 15 amperes, watch the ammeter until a point on the resistance unit is touched when that amount is flowing.

If the relay has a tendency to break the circuit before 15 amperes is reached, the tension spring should be stiffened. If the relay does not open at 16 amperes the tension spring should be weakened until the contacts will open. Then test again in the same way.

Do not attach wire from 2 terminal to the resistance unit at any point. Only touch it to the resistance wire long enough to get a reading.

Figure 56 shows method of testing motor and generator armature for open circuits. To make this test, proceed as follows: Disconnect the field from the armature. Connect the brushes to a source of current such as single dry cell and have a resistance unit connected in series with the source of current and the armature as shown in Figure 56.

An ordinary 6-volt, 20-candle power headlight bulb may be used to take the place of a resistance unit. This will allow about one ampere of current to flow. Using the 3-volt range of a Western Model 280 Volt-Ammeter, measure between adjacent segments of the commutator.

If an open circuited coil is across the ends of the testing cables which are connected to the Volt-Ammeter, an indication will be obtained which is relatively large as compared to that obtained from a good coil. It is absolutely necessary that good contact be had at the commutator segments, in order that reliable results be obtained.

Always press button as shown in diagram to get voltage reading. If commutators are dirty or gummed up they should be cleaned before making these tests. To clean a commutator, first apply kerosene (coal oil) and allow to remain on commutator for five minutes. Then wipe dry with cheese cloth.

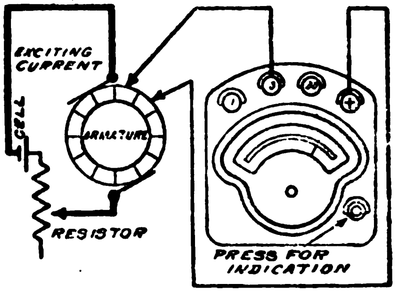
Figure 57 shows method of testing a motor or generator armature for short circuits. To make this test, proceed as follows: Disconnect the field from the armature. Connect for test as shown in Figure 56 and test for open circuits as already described in the preceding paragraphs on open circuits in armatures.

Now change the connections from the 3-volt range to the O. I. volt range and measure between commutator segments.

If a short circuit exists in any coil the indication obtained, when the voltmeter is connected to the ends of that coil, will be very much less than the indication obtained from a good coil.

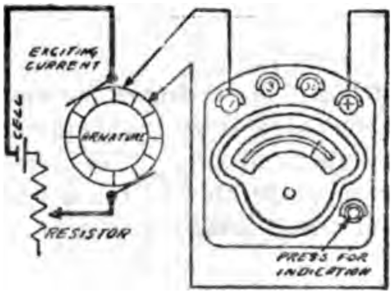
NOTE. This is one of the special cases when the O. I. volt range should be used. If the indication is too large for this range, decrease the flow current from the dry cell by inserting a resistance unit of higher resistance or by using a head light bulb of a lower candle power.

The change of resistance must not be too great. If a lamp is used, first try a 20-candle power and if the indication is too great for the range, try a 16-candle power lamp.



—Connections for Locating Open-circuited Coil in Armature of Starting Motor and Generator.

FIG. 56



—Connections for Locating Short Circuits in the Armature of the Starting Motor or Generator.

Inspection and Testing

FIG. 57

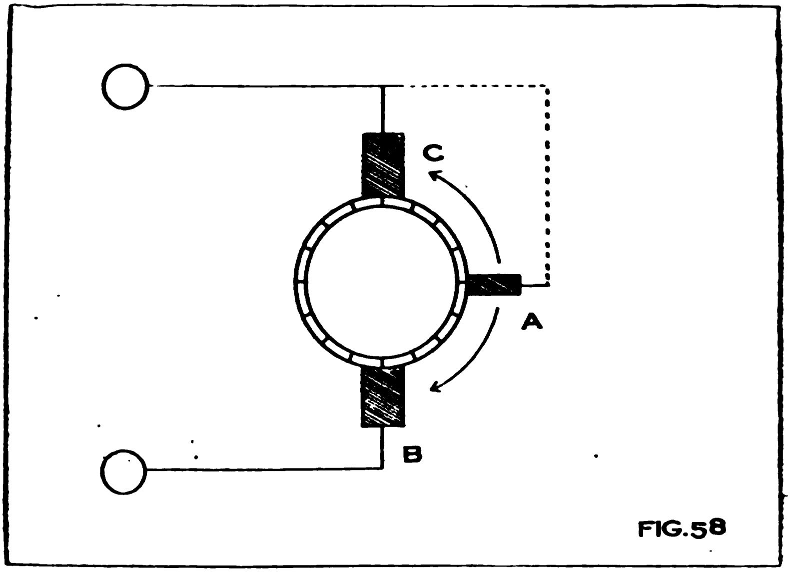


FIG.58

Figure 58. Method of increasing or decreasing the output of a generator employing third brush regulation. Dotted line represents the field coil circuit. To increase the output of the generator, move brush "A" toward brush "B." To decrease output of the generator, move brush "A" toward brush "C."

Figure 59.. This shows top view of a cut-out relay with primary terminals numbered 1 and 2. No. 3 is the frame or one end of the voltage winding of the relay. To find the terminal that the other end of the voltage winding is connected to use a pair of test cords with a lamp in the circuit. Use 110 volts. Touch one end of test cord to frame of relay and the other end to terminal 1 and then to terminal 2.

When terminal is touched and lamp burns or a spark is produced, this is the other end of the fine winding. This terminal should be connected to the generator and the other

[redacted]

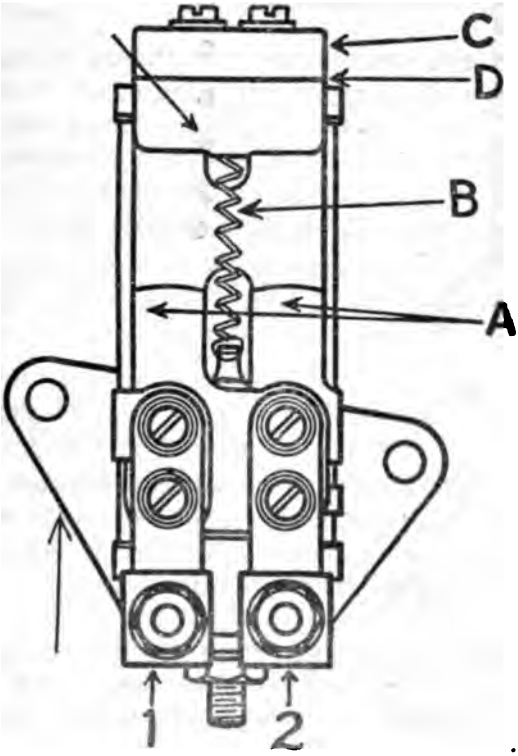


FIG. 59

terminal where the light would not light or no spark was produced when touched should be connected to the storage battery.

"A" shows contact springs, "B" tension spring, "C" armature pin and "D" is the armature.

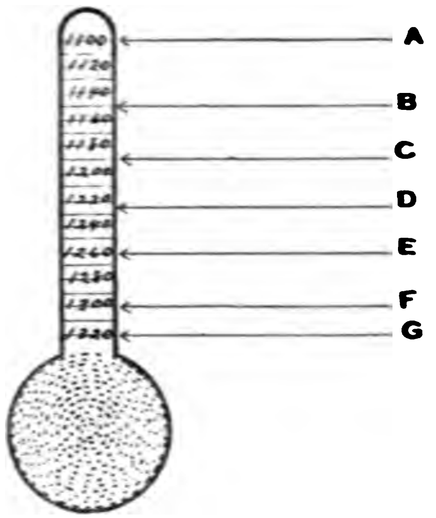


FIG. 60

Fig. 60. This is used to show a hydrometer. This is the part that is in the glass barrel of a hydrometer syringe. The hydrometer is used to test the specific gravity of the electrolyte of storage batteries. Directions for using are as follows:

After removing the filling plug from the cover of the cell, compress the rubber bulb of the syringe and insert the pipette in the solution of the cell to be tested. Holding the instrument as nearly vertical as possible, gradually lessen the pressure on the bulb until the electrolyte rising in the barrel causes the hydrometer to float.

In general, only enough electrolyte should be drawn to float the hydrometer free of the bottom by about one-half to three-quarters of an inch. The specific gravity reading is taken on the hydrometer at the surface of the electrolyte in the glass barrel.

If the electrolyte is below the top of the plates, or so low that enough cannot be drawn into the barrel to allow of a proper reading of the hydrometer, fill the cell to the proper level, by adding pure water; then do not take a reading until the water has been thoroughly mixed with the electrolyte. This can be accomplished by running the engine for several hours.

The specific gravity of the electrolyte is an indication of the amount of charge in the battery. In a fully charged battery the specific gravity should be from 1.275 to 1.300. When the gravity registers from 1.150 to 1.175 the battery is practically discharged, and should be recharged.

If surface of electrolyte is at "A," the gravity of the solution is 1.100. If surface of electrolyte is at "B" the gravity is 1.150. At "C" it is 1.190. At "D" it is 1.225. At "E" it is 1.260. At "F" it is 1.300. At "G" it is 1.320.

The solution should never test over 1.300 and if it does test over 1.300 it should be weakened until it is at or below 1.300 when battery is fully charged.

All of the cuts appearing on page -- are reproductions from our number one book. We want to point out the importance of following these diagramatic instructions. There are always two ways of doing work. Here we are showing both of them. We show the right way to start the cut when grooving out micas in a commutator and then show how the grooving should be done. First note that a three cornered file is used to start the slot. Then a hack saw blade is used of the proper thickness. The mica should be grooved out about .035 inch deep.

Next we show that the mica must be cut away clean which is the right way and then we show the wrong way in three different forms. Note this very carefully. If the brushes strike the sharp corners of the mica the micas will be chipped off and drawn under the brushes which will cause arcing and burning of the commutator.

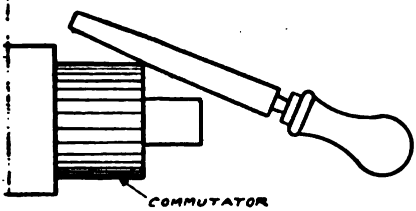
When sanding commutators as shown in the next cut the

armature should be revolving. Use medium fine sand cloth and draw the ends back and forth while sanding. Have strip of sand cloth full width of the commutator. Use extra fine sand cloth to finish and then polish with a piece of cheese cloth.

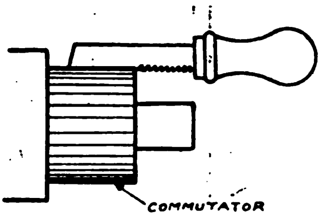
Brushes must be well fitted to a commutator to secure the best results. In one place we show the proper way to fit a brush and then we show we wrong way. This is taken from an end view. The total end surface of all brushes should be in contact with the commutator.

Taken from a side view of the commutator we show a strip of sand cloth the proper width and then we show in the next cut a strip of sand cloth which is too narrow. As 95% of all generator troubles occur at the commutator or the brushes, we want you to give these cuts special attention so you will realize the importance in following them.

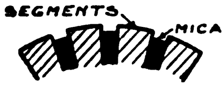
COMMUTATOR AND BRUSHES



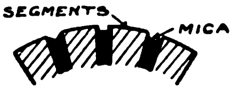
STARTING GROOVE IN MICA WITH 3-CORNERED FILE
FIG.- 18.



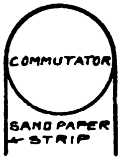
SLOTTING MICA WITH PIECE OF HACKSAW BLADE
FIG.- 19.



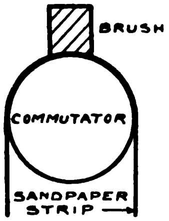
RIGHT WAY
MICA MUST BE CUT AWAY CLEAN BETWEEN SEGMENTS.
SLOTTING MICA
FIG.- 20.



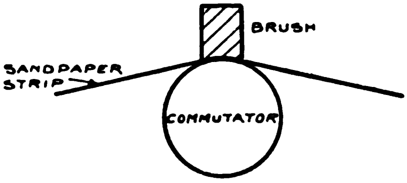
WRONG WAY
MICA MUST NOT BE LEFT WITH A THIN EDGE NEXT TO SEGMENTS
SLOTTING MICA
FIG.- 21



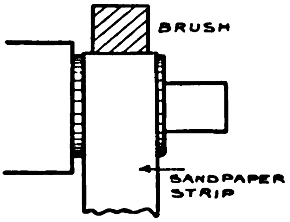
SANDING COMMUTATOR
FIG.- 22



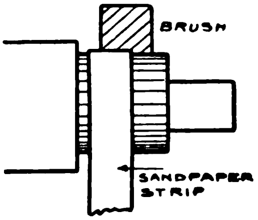
RIGHT WAY
FIG.- 23



WRONG WAY
FIG.- 24



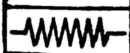
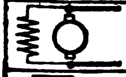
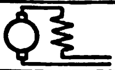
RIGHT WAY
FIG.- 25



WRONG WAY
FIG.- 26

SANDING BRUSHES

SIGNS, SYMBOLS AND ABBREVIATIONS.

+	POSITIVE
—	NEGATIVE
⟶	ARROW INDICATES DIRECTION
	CLOCKWISE REVOLUTION.
	COUNTER-CLOCKWISE REVOLUTION.
	COIL OF INSULATED WIRE. (COARSE.)
	COIL OF INSULATED WIRE. (FINE.)
	AMMETER.
	VOLTMETER
	SHUNT WOUND MACHINE.
	SERIES WOUND MACHINE.
	GENERATOR.
	MOTOR
	WIRES JOINED TOGETHER.
	WIRES CROSSING.
	RHEOSTAT OR VARIABLE RESISTANCE.
	INCANDESCENT LAMP.
	DRY CELLS OR STORAGE BATTERY. CELLS IN SERIES.
V	VOLT
A	AMPERE.
D.C.	DIRECT CURRENT.
A.C.	ALTERNATING CURRENT.
K.W.	KILOWATT. (1000 WATTS).
H.P.	HORSE POWER (746 WATTS).

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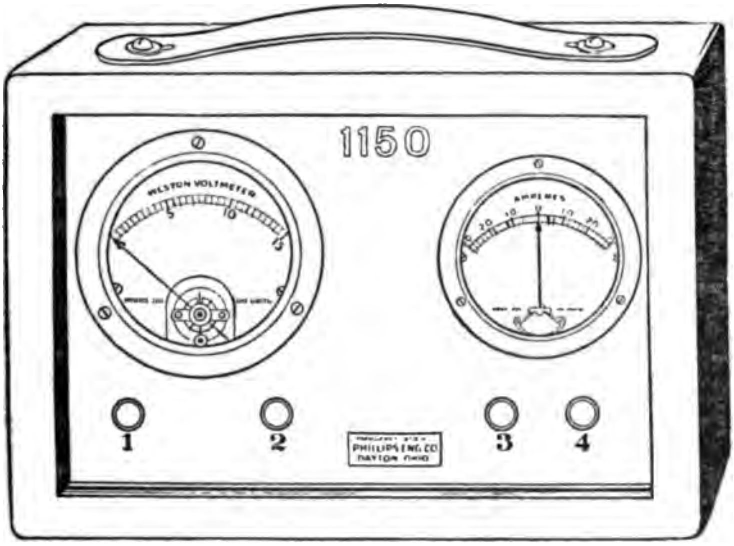
PHILLIPS TEST SET MODEL 302



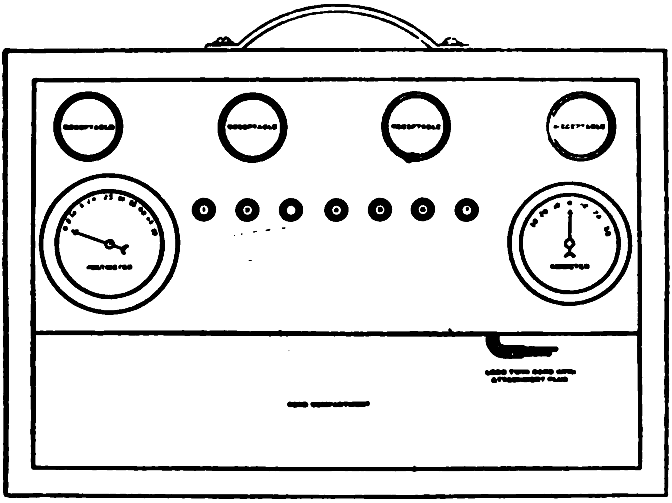
Standard set as described below $25.00. Special set with voltmeter reading from 0 to 15 volts and 0 to 150 volts with same ammeter, cords and instruction book, $30.00.

STANDARD MODEL 302

This is a new design and is very small and compact. The cabinet is made of oak. Size of cabinet is 9 x 6 x 4 inches.

The voltmeter reads from 0 to 15 volts and the ammeter reads from 0 to 30 amperes either way, being known as the center zero type. One pair of No. 10 test cords and special picture instruction book are supplied with each set. No service station or garage is complete without this instrument. No danger of injuring the instruments if wrong connections are made in testing automobile electric systems. If the user allows the ammeter to remain in a circuit too long where the drain on the battery is above the scale reading, the attachment cords may be burned up. In this case it will cost $2.00 for a new pair.

THE PHILLIPS TEST AND CHARGING SET—MODEL 32



Price $30.00

WHAT IT CONSISTS OF The set consists of the instrument case and two sets of test cords.

The following instruments are mounted on the front of the instrument case: Weston voltmeter, Weston ammeter, four lamp receptacles, and seven jacks.

VOLT METER. The volt meter reads from 0 to 50 volts and can be used in taking all voltage readings up to 50 volts.

AMMETER. The ammeter reads 30-0-30, being known as the center zero type. It reads from 0 to 30 to the right and from 0 to 30 to the left.

HOW IT HELPS YOU. It is a means of getting all electrical troubles quickly and accurately located.

It does not require an expert electrician to use it.

It enables the mechanic to quit guessing and to say positively WHERE the trouble is, and WHAT it is.

32 OR 110 VOLT ATTACHMENTS. This attachment is for making connection to the 32 or 110 volt light or power circuit. By attaching to a 32 or 110 Volt D. C. circuit and inserting resistance lamps in the receptacles, current may be used for charging batteries.

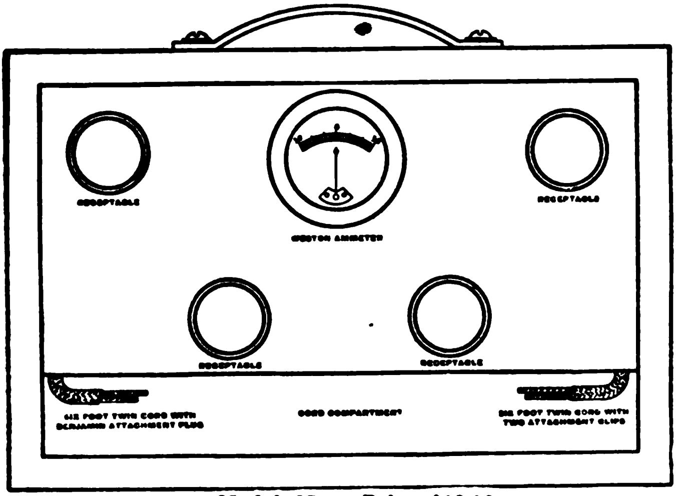
Current may be taken, using one receptacle to make high voltage tests for short circuits, open circuits, grounds, etc.

TEST CORDS. The test cords consist of two No. 10 flexible cables and one twin test cord.

All cords have a plug on one end for plugging into the jacks and a spring clip on the other end as a handy means of attaching to apparatus to be tested.

JACKS. The seven jacks in the lower row afford a means of making connections between the instruments in the instrument case and the apparatus to be tested. All jacks are marked, making all connections easily understood.

PHILLIPS CHARGING SET



Model 354. Price $12.00

INSTRUCTIONS FOR CHARGING STORAGE BATTERIES

Insert attachment plug in 32 or 110 volt lamp socket. Screw lamps or resistance units in receptacles. Touch attachment clips together. If ammeter hand moves to the right, connect red clip to positive terminal of the battery. If ammeter hand moves to the left when attachment clips are touched together, connect black clip to the positive battery terminal. Make this test every time when charging batteries. When charging, the ammeter indicates the rate the battery is being chargd. Charging rate may be varied by using larger or smaller lamps or resistance units. Keep front cover in cabinet when not in use. Direct current must be used. When source of charging current is 32 volts, 5 batteries may be charged at a time. When using 110 volt current, 16 batteries may be charged at a time. The instrument case is of oak. Size of case, 12 in. long, 8 in. high and 5 in. deep.

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